# RESIDENT INSTRUCTION BULLETIN

**PUNJAB AGRICULTURAL UNIVERSITY**
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**2024**

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# FOREWORD

The Punjab Agricultural University (PAU), established in 1962, has been a cornerstone of agricultural education, research, and extension in India. Over the past six decades, it has significantly contributed to transforming Indian agriculture, from the Green Revolution to the adoption of modern, sustainable, and precision-based farming practices. The University's alumni, comprising eminent scientists, teachers, and extension specialists, have played a pivotal role in advancing agricultural productivity and improving the livelihoods of farming communities across the nation.

Since its inception, PAU has pursued excellence in teaching, research, and outreach. The University views education not merely as the transmission of knowledge but as a dynamic process that shapes intellect, character, and values. Its curriculum is conceived as a living framework that encourages curiosity, innovation, and engagement with real-world challenges. By fostering a spirit of inquiry and critical thinking, PAU seeks to empower learners to realize their potential and contribute meaningfully to society.

In keeping with its commitment to relevance and innovation, PAU has continuously restructured its academic programmes to align with emerging needs in agriculture and allied disciplines. While the initial focus centred on increasing crop productivity, contemporary priorities include precision and conservation agriculture, climate-resilient practices, and advanced post-harvest management. The University emphasizes the development of a highly skilled human resource base with both national and global exposure, ensuring that its graduates are equipped to address complex challenges in the agricultural sector.

PAU regularly revises its curricula in accordance with the guidelines of the Indian Council of Agricultural Research (ICAR). The undergraduate programmes follow the framework prescribed by the Fifth Deans' Committee, while postgraduate programs at the master's and doctoral levels are designed as per the ICAR's BSMA (Broad Subject Matter Area) report. The undergraduate curriculum was revised and implemented in 2016-17, and the postgraduate curriculum underwent revision in 2022-23. These revisions reflect a conceptual shift towards flexibility, interdisciplinarity, and holistic learning, in line with the provisions of the National Education Policy (NEP) 2020. The revised structure enables students to plan their coursework in alignment with their research interests and career goals.

Periodic revision of the Resident Instruction Bulletin (RIB) remains an essential component of PAU's academic strategy. Updating the RIB in accordance with ICAR's recommendations and the evolving requirements of students and stakeholders ensures that the University remains responsive to global advancements in agricultural education and research. The 2024 edition of the RIB embodies this commitment by presenting updated and comprehensive information on course curricula. Sincere appreciation is extended to the Editorial Board for their dedicated efforts in revising and refining the RIB, ensuring that it continues to serve as a reliable academic guide. The updated RIB will be a valuable resource for both students and faculty in academic planning and professional development.

PAU's sustained dedication to innovation, quality, and relevance continues to uphold its reputation as a leader in agricultural education. Through its adaptive curriculum, research-driven approach, and focus on holistic learning, the University remains steadfast in its mission to advance agricultural science and to nurture the next generation of professionals poised to lead India's agricultural transformation.

Gosal

**(Dr. Satbir Singh Gosal)**
Vice-Chancellor

# PREFACE

Since its inception in 1962, the Punjab Agricultural University, Ludhiana has been striving for excellence in agriculture education and research. The University has played an important role in developing agriculture in not only the country but also across the world. Students from across the globe seek admission to this institute.

The Resident Instruction Bulletin (RIB) of the PAU is a comprehensive document containing complete information of all the courses and their curricula, being offered by the University. The PAU has six constituent colleges viz: College of Agriculture, College of Horticulture and Forestry, College of Agricultural Engineering and Technology, College of Basic Sciences and Humanities, College of Community Science and College of Agriculture at Ballowal Saunkhri. There are 32 Departments and 3 Schools; namely School of Agricultural Biotechnology, School of Organic Farming and School of Business Studies. The University offers 11 Bachelors, 45 Masters and 30 Doctoral programmes through its Colleges and Departments.

The University initially followed the trimester system of teaching, as followed in the Ohio State University, Columbus, USA, which assisted during the formative stage of the University. The University shifted to semester system in 1988 to meet the growing needs and demands in the ever changing agricultural scenario at national and international level.

The PAU follows the ICAR's Deans' Committee recommendations for the Undergraduate teaching curriculum. The ICAR recommendations are based on contemporary challenges for employability of passing out graduates and to adopt a holistic approach for quality assurance in agricultural education. The recommendations of fifth Deans' Committee include common courses like Environmental studies, Disaster management, Communication skills, Entrepreneurship development etc. across all the curricula. For development of skills of agricultural graduates, Student READY (Rural and Entrepreneurship Awareness Development Yojana) was initiated.

For Postgraduate teaching, PAU follows the recommendations given by the National Core Group (NCG). On the recommendations of the NCG, 19 Broad Subject Matter Area (BSMA) Committees constituted by the ICAR put forward the structure and curriculum for the Masters and Ph.D. programmes.

Collaborative and inter-disciplinary postgraduate education has been facilitated by operationalizing MoUs with national/international institutes/universities/organisations to ensure quality of resident instructions. Various academic rules and regulations have also been amended which are incorporated in this revised edition.

It is my privilege to place on record the sincere efforts carried out by the faculty, Heads of the Departments, Secretaries of the Board of Studies of the constituent Colleges, Deans of the Colleges, members of Resident Instruction Committee and the Academic Council for suggestions, critical appraisal and approval of the course curricula/syllabi, various academic rules and regulations. I gratefully acknowledge sincere efforts in updating the information from time to time by my predecessors. Thanks are due to the Members of the Editorial Board for their dedicated efforts in preparation of the RIB. I am thankful to Dr Rishi Pal Singh, Registrar of the University, for updating the information relevant to his office. Drs Rohinish Khurana (Professor-FMPE), Snehdeep Kaur (Assistant Professor-Education), S K Dhillon (Professor of Plant Breeding and Genetics), Rajni Sharma (Professor of Botany), Ritu Gupta (Associate Professor of Resource Management and Consumer Science) and Dr Trina Adhikary (Assistant Professor-Education), deserve special appreciation for their co-operation in finalising the Document.

I express my deep sense of gratitude to Dr SS Gosal, Vice Chancellor, Punjab Agricultural University, Ludhiana for his able guidance, foresight and vision in preparation of the Document.

M.I.S Gill

(Dean, Postgraduate Study)

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SECTION I

# GENERAL INFORMATION

## 1. HISTORY

After taking over the East India Company during 19th century, the British Government in India was interested in developing agriculture mainly from point of view of boosting exports to the United Kingdom and initially did little to strengthen agricultural research and development. India faced a series of famines due to crop failures in the second half of 19th century. The Famine Commission of 1880 was the first to draw the attention of the Government to the need for promoting/disseminating agricultural education as pre-requisite to achieve food security. As a follow up action, Dr J A Voelcker, Consultant Chemist to the Royal Agricultural Society, was sent to India in 1889, who recommended dissemination of agricultural education in the country. Further, the Famine commission in 1901 called for strengthening of agricultural development in all provinces. Consequently, in the year 1903, Imperial Agricultural Research Institute was established at Pusa in Bihar. In pursuance of this policy, agricultural colleges were started at Pune, Kanpur, Lyallpur (now Faisalabad in Pakistan), Coimbatore and Sabour between 1906 and 1908. These colleges across the length and breadth of the country, did a lot to promote the development of agricultural education and research.

In 1928, a Royal Commission was appointed which emphasized further strengthening of agricultural research and education by upgrading the five colleges. The Commission also recommended the establishment of Central Council of Agricultural Research for promoting, guiding and coordinating agricultural research throughout India and linking it with Agricultural Research in other parts of the world. Hence, the Imperial (now Indian) Council of Agricultural Research was set up in 1929. Earlier, in 1926, Sir John Russell and Dr N C Wright studied working of the Council to make suggestions for further strengthening the coordination activities relating to agricultural research. They particularly recommended that the research findings should be made readily available to the farmers. As a policy, it was decided to establish more agricultural and veterinary colleges in the country and consequently there were 17 Agricultural and Veterinary Colleges in India at the time of Independence in 1947.

To begin with, a 3-year diploma course called Licentiate in Agriculture (L.Ag.) was started at Punjab Agricultural College and Research Institute, Lyallpur in 1909 which was later replaced by a 4-year degree course leading to B.Sc. in Agriculture and the first batch graduated in 1921. To meet the demand of faculty in the growing area of agricultural education, the diploma holders were taken on the staff of the college, who after passing the B.Sc. (Agri.) as private candidates became the first agriculture teachers. Earlier, most of the teachers were either Britishers or Indians with degrees in pure sciences, languages, mathematics, etc. After partition of the country in 1947, the College re-established itself in a building belonging to Khalsa College, Amritsar. Subsequently, in May, 1949, it was temporarily shifted to Malwa Khalsa High School at Ludhiana. The College shifted to its present site in 1957 where it attained the status of the University in October, 1962.

Dissemination of agricultural education got the real impetus in 1949 with the strong recommendation by University Education Commission chaired by Dr S Radhakrishnan to establish Rural Universities in the states of India. As India was facing acute shortage of food grains in the early fifties, the Government of India constituted joint Indo-American Team which submitted its report in 1955. The Team endorsed the recommendations of the University Grants Commission to set up Rural Universities which would have on the campus Colleges of Agriculture, Veterinary Science, Home Science, Basic Sciences and Agricultural Engineering so that the farmer is served from one basket.

The Punjab Agricultural University (PAU), Ludhiana, came into existence in October, 1962 following a notification by the Government of Punjab on 18th October, 1961. This was the third agricultural university, to be established in India, the first being at Pantnagar in Uttar Pradesh (1960) and the second at Bhubaneshwar in Orissa (1962). Sardar Partap Singh Kairon, the then Chief Minister of Punjab who had received Masters degrees in Economics and Political Science from University of California, Berkeley and University of Michigan, USA, respectively which were established as Land Grant Universities. Sardar Kairon fully appreciated the vast potential of establishing a university on this pattern and gave full support to the first Vice Chancellor, Dr P N Thapar. The University, therefore, developed at a very fast pace at its two campuses at Ludhiana and Hisar, the

former being the centre of undergraduate and postgraduate education in agriculture and the latter in veterinary science. The third campus was established at Palampur in July 1966 to look after the special needsof Himalayan Punjab. After the establishment of Punjab Agricultural University, the existing sections of the State Department of Agriculture, Punjab, were maintained as such, but later on with the appointment of full University Professors and the establishment of the constituent colleges, these were redesignated as University Departments. The Heads of Departments were given greater financial and administrative powers than those enjoyed by the Heads of Sections, which was the most significant step in the rapid development of the University.

With the re-organization of the state of Punjab on 1st November, 1966, two new states i.e. Haryana and Himachal Pradesh were carved out and thus the division of the old Punjab Agricultural University became inevitable so as to serve adequately the three corresponding states. An ordinance was promulgated in 1970 to provide for the establishment of two independent Agricultural Universities, namely the Punjab Agricultural University and the Haryana Agricultural University. This ordinance was subsequently adopted as an Act of Parliament namely, the Haryana and Punjab Agricultural Universities Act (1970) which came into force on 2nd April, 1970. Later, in July 1970, with the formation of the Himachal Pradesh Agricultural University, the College of Agriculture at Palampur wastransferred to that University.

After the establishment of the Punjab Agricultural University in October 1962, fifty three faculty members were sent abroad under the USAID programme, mostly to Ohio State University for higher educational trainings leading to Ph.D. degrees in various faculties. Twenty three faculty members ofthe University were sent on short visits for specific job trainings. During the period of the contract,thirty three technicians and advisors from Ohio State University came to PAU for periods varying from three months to three years. With this, efforts were initiated to develop a sound scientific base with human resource capable of carrying out advanced research, education and extension programmes. Over the years, the University expanded its resident instruction programmes by establishing the College of Agricultural Engineering (1964), College of Basic Sciences and Humanities (1965), College of Home Science (1966) and College of Veterinary Sciences (1969) at Ludhiana, anda College of Home Science at Kaoni (1978), which, however, had to be closed due to poor response of students to B.Sc. Home Science programme. In 2006, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) was carved out of Punjab Agricultural University, and the College ofVeterinary Science became a part of GADVASU.

At present, there are six constituent colleges in the University: College of Agriculture (COA), PAU-College of Agriculture, Ballowal Saunkhri, College of Horticulture and Forestry (COHF), College of Agricultural Engineering and Technology (COAET), College of Basic Sciences and Humanities (COBSH) and College of Community Science (COCS). As per the emerging needs and the priorities of the agricultural sector, new schools, centres, departments, regional research stations, sub-stations and seed farms were created/re-organized. These included Biotechnology Centre (1990), upgraded to School of Agricultural Biotechnology in 2008; Institute of Agriculture at Gurdaspur (1993) and Institute of Agriculture at Bathinda (2014). Earlier there was a School of Energy Studies for Agriculture which has been renamed as School of Renewable Energy Engineering in August 2016, and again renamed as Department of Renewable Energy Engineering in 2018 while Department of Business Management was upgraded to School of Business Studies and Department of Agricultural Meteorology to School of Climate Change and Agricultural Meteorology (2012). In the College of Community Science, as per the recommendation of ICAR's Fifth Deans' Committee and BSMA, the degree programme B.Sc. (Hons) Home Science has been renamed as 'B.Sc. (Hons) Community Science' in 2016-17. The College of Home Science was renamed as 'College of Community Science' in the year 2019-20. There had been changes in the nomenclature of various departments from time to time. The Department of Home Science Extension and Communication Management has been renamed as 'Department of Extension Education and Communication Management and the Department of Human Development was renamed as 'Department of Human Development and Family Studies' (2016). In 2023, the Department of Family Resource Management has been renamed as 'Development of Resource Management and Consumer Science.' The college has started two new Certificate Courses of one year duration each namely 'Certificate course in Early Childhood Care and Education' and 'Certificate course in Interior Design and Decoration' From the academic session 2024-25. The College of Basic Science and Humanities started new programmes in the year 2021-22 viz. B.Sc. (Hons) in Agribusiness Management (4 year), 5 year integrated M.Sc. (Hons) in Physics and M.Sc. degree programme in Mathematics. Farm Machinery Testing Centre under the control of Farm Machinery and Power Engineering was established in the year 1969. The Department of Electrical Engineering and Computer Science has been merged with School of Information Technology, which was established in 2009, to form School of Electrical Engineering and Information Technology in 2012 and was renamed as Department of Electrical Engineering and Information

Technology in 2018. Presently three Centres for Advanced Studies in Farm Power and Machinery, Genetics and Plant Breeding and Soil Science were established in 1994 with the financial support from the ICAR. Also, there are two Centres for Advanced Faculty Training (CAFT), one each in the Departments of Plant Breeding and Genetics, and Soil Sciences. Eighteen Krishi Vigyan Kendras are also operational in the University, with the support from ICAR.

By and large 1970s were the era of expansion in PAU, while 1990s were the period of consolidation.Human Resource Development Cell and the Centre of Studies in Rural Development were abolished and the work was entrusted to Departments of Extension Education, and Economics and Sociology which already had these programmes. The Department of Seed Science and Technology founded in 1991 was converted into Seed Science and Technology Centre in 1999 and merged with the Directorate of Seeds. During 1999, total staff strength of the University was reviewed rigorously and the proposed faculty strengths of various departments were fixed. Through this exercise, the total faculty and staff strengths in the University was proposed to be reduced by 20 and 24 per cent, respectively within the next five years. Presently, the sanctioned strength of faculty is 407 (COA), 73 (COHF), 127 (COAET), 56 (COHS), 218 (COBSH) and staff is 621 (COA), 300 (COAET), 78 (COCS) 256 (COBSH) against which in-position strength of faculty is 273 (COA), 79 (COAET), 33 (COCS) 115 (COBSH) and the University staff strength is 1642.

At the time of the establishment of the PAU, only Bachelor's degree programmes were offered. These programmes were B.Sc. (Agri.) at Ludhiana and B.V.Sc. & A.H. at Hisar. On the pattern of theland grant colleges in USA, the University introduced trimester system of education for M.Sc. and Ph.D. programmes in 1963 and for Bachelor's programmes in 1964. To begin with, M.Sc. degree and Ph.D. programmes were offered only in 12 and 8 disciplines, respectively. Keeping in view the emerging needs of the agricultural sector, the resident instruction programmes at the University were expanded, diversified and re-modeled from time to time. New Master's programmes in Food Technology (1969), Agricultural Journalism (1970), Floriculture (1970), Business Management (1971), Agro-meteorology (1979) and Fisheries (1997) were started for the first time in India at the PAU. In 1988, the University shifted from trimester to semester system and in 1993 from letter grade system of evaluation to 10.00 credit point scale. As a sequel to the recommendations of the ICAR's National Core Group (NCG) and V Deans' Committee, the course curricula for all the postgraduate and undergraduate programmes were reviewed and re-oriented in 2009 and 2016, respectively. The Postgraduate course curriculum was restructured and revised as per BSMA recommendations and implemented in the academic session 2022-23 for both masters and Ph.D. degree pogrammes. The nomenclature of different degree programmes was also revised as per BSMA recommendations. The University regularly reviews its academic programmes and closes down those programmes which lost their relevance. A two year diploma in Dairy Technology, started in 1979, was discontinued in 1991 due to the lack of employment opportunities for these technicians. Likewise, four year B.Sc. (Forestry) programme started in 1985 was discontinued in 1987. One year Certificate Course in Pesticides and Fertilizers started in 1993 was discontinued in 1998 due to diminishing employment opportunities for these certificate holders.

In view of the demand-driven employment opportunities, other programmes were introduced viz. Bachelors' in Biotechnology (2008-09), Fashion Designing (2008-09), Food Technology (2009-10), Nutrition and Dietetics (2009-10) and Interior Design (2014-15); Computer Science Engineering (2000-01), Horticulture (2019-20), Master's in Agribusiness (2004-05), Journalism and Mass Communication (2008-09), Computer Application (2009), Fashion Designing (2011-12), Remote Sensing and GIS (2012) and Mechanical Engineering (2014). A 5-Year Integrated Masters' programme was also started in the disciplines of Biochemistry, Botany, Microbiology and Zoology (with the provision that a student can opt to take a Bachelor's degree after six semesters' course work) in the year 2008 and in Chemistry in 2011. Ph.D. programme in Biotechnology (2009-10) was also introduced. Ph.D. programmes in Business Administration, Chemistry (2012-13) and M.Sc. programme in Statistics (2016) have also been revived. To attract rural students, 6-year bachelor's programmes after 10th standard were started in the faculties of Agriculture and Home Science in 2008-09 which were discontinued in Home Science in 2013-14 and in Agriculture in 2015-16. B.Sc. Interior Design programme – year duration which was started in 2014-15, was discontinued in the year 2019-20. However, the 6-year B.Sc. Agri. (Hons) programme was started in the Institutes of Agriculture at Gurdaspur (2013-14) and at Bhathinda (2014-15), wherein the students completed their first two years at the Institutes and remaining at COA in PAU, Ludhiana. The first two years curriculum of B.Sc. Agri. (Hons) 6 year programme was reworked to include Physics, Chemistry and Biology courses equivalent to 10+1 and 10+2 (Medical stream) classes of the Punjab School Education Board in 2015-16.

The University was nurtured well and developed to its present state of excellence under the guidance of outstanding personalities who served as Vice Chancellors for varying periods. Dr P N Thapar, ICS a renowned administrator was the founder Vice Chancellor and continued upto October 1968, followed by a great visionary Dr M S Randhawa, ICS who completed his term in October, 1976. Thereafter, Dr A S Cheema completed his term in March, 1981, Shri I C Puri, IAS (who held additional charge) in November, 1981, Dr Sukhdev Singh in December 1989, Dr Khem Singh Gill in December, 1993, Dr A S Khera in December, 1997, Dr G S Kalkat, an eminent Agricultural Scientist and Administrator in March, 2001, Dr K S Aulakh in April 2007, Dr M S Kang in April 2011 and Dr B S Dhillon in June 2021. Presently, Dr S S Gosal, an internationally acclaimed Agricultural Biotechnologist is the Vice Chancellor of the University since August, 2022.

During the last 62 years of its existence, the University holds the distinction of having very competent faculty and produced distinguished alumni, who, in recognition of their outstanding achievements, have brought laurels and won many prestigious awards at national and international level which include World Food Prize, Rafi Ahmed Kidwai Memorial Award, Shanti Swaroop Bhatnagar Award, Om Parkash Bhasin Award for Science and Technology and Team Research Awards of ICAR apart from several others awards including the prestigious Padma Bhushan and Padma Shree. The PAU alumni also served on distinguished positions in national and international organizations. The PAU faculty has also been bestowed with professional fellowships, like, NAAS, FNA, FNSc, NASI, German Academic Exchange (DAAD) Fellowship, Alexander von Humboldt Fellowship, Fulbright Nehru Fellowship, and academic scholarship/fellowships, like Commonwealth Academic Staff Scholarships and several others.

COAET and COA received the Federation of Indian Chambers of Commerce and Industry Awards in 1975 and 1977, respectively. The PAU received Best Institution Award of ICAR in 1995, in the very first year of institution of this prestigious award. A first ever special grant of Rs. 100 crore was awarded to the University by the Government of India for undertaking basic and strategic research in agriculture in the year 2006. In 2010, the University earned the distinction of being the first State Agricultural University to be conferred with the first International Potash Institute (Switzerland) and Fertilizer Association of India (IPI-FAI) Award for transfer of technology in the balanced use of fer- tilizer. PAU was again the first University to bag the Agricultural University of the year 2011 Award (Krishi Shiksha Samman) in the first year of the institution by the Mahindra & Mahindra. COAET received Outstanding Institution Award from NITTTR in year 2016-2017. The University along with all the constituent colleges was Accredited by the Accreditation Board set up by the ICAR for further accreditation of the University and consequently PAU stand accredited till 2024. College of Horticulture and Forestry (2024) was established in 2018. Bachelor's degree in B.Sc. (Hons.) Horticulture was started in 2019 and after 4 years of bachelor's the foundation batch completed the degree in 2023. After passing of 1st batch, the college got accreditation from ICAR in 2024.

The Punjab Agricultural University is spread over an area of about 1222 acre at Ludhiana and about 5742 acre at various Regional Research Stations (7), Fruit Research Stations (3) and Seed Farms (5) located in different agro-climatic zones, KVKs (18) and FASC (15) in different districts of the State. The teaching, research and extension education programmes of the University are implemented through 32 Departments, 3 schools, *viz.* School of Agricultural Biotechnology, School of Organic farming and School of Business Studies and 2 Institutes of Agriculture (at Bathinda and Gurdaspur) and Research Stations/Seed Farms/KVKs/FASCs. The budget of the University has also shown a progressive increase from Rs.1.27 crore in 1963-64 to 879.58 crore in 2023-24, the contribution of State Government and ICAR being 79.9 per cent and 13.4 per cent respectively, while the rest is generated from own resources and other state, national and international agencies. The allocation of budget for research, teaching, extension and administration is about 52, 24, 13 and 11 per cent, respectively.

The Punjab Agricultural University was established with the mission to produce trained scientific human resource capable of imparting higher education and undertaking conceptualized research and extension education activities for increasing agricultural productivity and improving the quality of life in rural areas. The University has developed dynamic course curricula in accordance with the education and research needs of the agriculture of the state and the country. The revision and modification in light of new emerging needs of farming community and developments in education technology is a regular feature of curricula development of the University. In the light of recommendations of V Deans' Committee and Broad Subject Matter Area (BSMA), and the requirements of syllabi of JRF and SRF and National Eligibility Test (NET), the revision of curricula was carried out and implemented with effect from 2016-17 for UG and 2022-23 for PG programmes.

## 2. LOCATION AND SETTING

The campus of the Punjab Agricultural University is located at Ludhiana. Ludhiana city is also called the Manchester of India and is well known for numerous small and medium scale industrial units, particularly those of hosiery, cycle parts and machine tools. In India, the District of Ludhiana also has the distinction of having the highest agricultural productivity per unit area.

The University was established with the mandate of:

i) Imparting education in different branches of study in agriculture, agriculture engineering, home Science and other allied sciences;

ii) Furthering the advancement of learning and prosecution of research particularly in agriculture and other allied sciences;

iii) Extension of research results to the rural people of the State of Punjab and Union Territory of Chandigarh; and

iv) Such other purposes as the State Government may notify direct.

## 3. ADMINISTRATION

**Board of Management**

The highest administrative and policy making body of the University is the Board of Management. This body controls the finances and assets of the institution. It is the appointing author-ity for all officers and teachers and provides overall guidance for the running of the University.The Chancellor (Governor of the State of Punjab) is the Honorary Chairman of the Board of Management. The Board consists of:

a. The Vice Chancellor as Working Chairman

b. The Chief Secretary to the Government of Punjab

c. Secretaries to the Government of Punjab in the Department of

   I. Agriculture

   II. Finance

d. The Director of Agriculture, Punjab

e. One nominee of the Indian Council of Agricultural Research, New Delhi

f. Persons not being officials, appointed by the Government of the State of Punjab from amongst the following categories namely:-

   i. Two from amongst persons who are, in the opinion of the Punjab Government, eminent agricultural scientists, with a background of agricultural research or education,

   ii. Two from amongst persons, who are, in the opinion of the Punjab Government, progressive farmers having experience of, and interest in scientific farming,

   iii. One from amongst persons who is in the opinion of the Punjab Government, a distinguished industrialist, businessman, associated with agricultural development, and

   iv. One from amongst women, who are, in the opinion of the Punjab Government, outstanding social worker, preferably with a background of rural advancement.

a. Registrar of the PAU as the ex-officio Secretary to the Board of Management

b. The Director of Horticulture, Punjab - Special Invitee

c. President, PAU Teachers' Association attends the meetings of the Board of Management asspecial invitee.

The non-official members of the Board of Management are appointed by the Punjab Government for a term of three years.

**Vice Chancellor**

The Vice Chancellor is the Chief Executive Officer of the University appointed for a term of four years. The Vice Chancellor has the powers to administer the University as an autonomous body. This position is held

by a man of great administrative experience, scientific bent of mind and one who could draw confidence of large number of scientists and has a high standing in the society so that his very association with the University earns it exalted recognition.

**Academic Council**

The Academic Council is the supreme body administering the academic affairs of the University. The Punjab and Haryana Agricultural Universities Act, 1970 (The Act) provides powers to the Academic Council to supervise, direct and control and be responsible for the maintenance of the standards of instruction, education and examination and other matters concerned with obtaining the degrees and to exercise such other powers and perform such other duties as may be prescribed. The Academic Council consists of the Vice Chancellor as Chairman, all the Deans and Directors, and one senior most Head of the Department from each constituent college as member by rotation.

**Research Council**

The Research Council is the supreme body administering the research activities of the University. The Act provides powers to prioritize, monitor and evaluate the research programmes; to extend physical, fiscal and administrative facilities required for implementing research projects; to orient research to meet farmers' and other stakeholders' needs and to promote public-private partnership, and to deal with any other matter pertaining to research programmes, which may be referred to it by the Vice Chancellor or the Board or any other authority of the University.

**Extension Council**

The Extension Council is the supreme body administering the extension activities of the University. The Act provides powers to make recommendations concerning extension education pro- grammes and projects of the University; to coordinate extension education activities; to develop farmers' education, training and advisory services; to monitor and evaluate the extension education programmes and projects of the University; and to deal with any other matter referred to it by the Vice Chancellor, Board or any other authority of the University.

**Resident Instruction Committee**

The Academic Council constitutes a standing sub-committee of the Academic Council for resident instructions. The Committee consists of all the Deans and Directors, Registrar, Controller of Examination, one senior-most Professor from each constituent college by rotation and President, PAU Teachers Association. The Dean, Postgraduate Studies is the Chairman of the Resident Instruction Committee. The functions of the Resident Instruction Committee as under:

The sub-committee shall advise the Vice Chancellor regarding the allocation of funds for Resident Instruction, the conditions for accepting grants and other matters affecting the resident programmes of the University and shall:

i) make recommendations to the Academic Council concerning the institution of the new curricula, re-arrangement, alteration and abolition of the existing curricula offered by the University;

ii) consider the recommendations of the various Boards of Studies and make recommendations to the Academic Council to ensure coordination and avoid duplication in the various courses offered by the constituent colleges; and

iii) recommend resident teaching programme for the University which would take into account the needs of all the students, teachers, research and extension education workers of the University. It will function in such a way that it would not in any way affect the jurisdiction of the Board of Studies.

**Postgraduate Committee**

The postgraduate Committee consists of all the Deans and Directors, Registrar (or his nominee), and one senior Professor from each constituent college by rotation. The Dean of Post-graduate Studies is the Chairman of the Postgraduate Committee.

The Postgraduate Committee has the general jurisdiction over all matters relating to Postgraduate education. The courses and curricula recommended for postgraduate students by the Board of Studies of the various constituent colleges are examined by the Postgraduate Committee before these are submitted to the Academic Council. The Committee meets at least once every semester.

**Board of Studies**

Each College has a Board of Studies. The Board proposes to the Academic Council (through Resident Instruction Committee) courses of study and curricula for the various programmes offered. The Board also reviews from time to time the standards of teaching and evaluation of students. The Vice Chancellor constitutes the Board of Studies of each College which consists of the Dean as Chairman, all Heads of Departments of the College and other Professor/Associate Professors, duly nominated.

**Registrar**

The Registrar is a whole-time Officer of the University who is responsible for the custody of the records and the common seal of the University. He is the ex-officio Secretary to the Academic Council and the Board of Management. He is responsible for maintaining a permanent record of all syllabi, curricula and students' academic record.

**Dr Mohinder Singh Randhawa Library**

The library is housed in a centrally air-conditioned building and has a seating capacity of 760 in its four reading halls. In addition to this, there are two fully air-conditioned outer reading halls Sh.T.P. Saxena reading hall and Dr. Kulbir Singh Gill reading hall which are open 24X7 for the library readers. Library is providing automated services to its end users through acquisition, technical, circulation, periodicals, reference divisions and a digital library. It is also maintaining a 'PAU Archives' separately. It has an inbuilt auditorium, Hall of Fame and a Museum of History of Agriculture in addition to 39 research carrels for the research scholars. The Library has total collection of 4,24,122 documents including print books, e-books, theses, bound journals and CDs. The library has subscribed to 65 e- journals and 05 online databases. The library is also providing an access to 385 e-books. Library got 11689 documents (theses and PAU publications) and three journals published by PAU namely Changi Kheti, Agricultural Research Journal and Progressive Farming (till 2016) digitized which were uploaded in PAU repository during this period.

**Book Banks**

Out of the Student's Aid Fund, multiple copies of text-books, magazines, etc. are purchased and kept in various colleges for issuing to the students for the entire semester. This service has become very useful and the students take full advantage of this facility. There are a total of 16,714 books in the three book banks of the constituent colleges.

SECTION II

# ADMISSION PROCEDURES AND ADMISSION RULES

## 1. Admission Procedures and Admission Rules

The academic year is generally from July to June and is divided into two semesters of 21 weeks each. The semester calendar for each academic year is issued by the Registrar during the second semester of the previous year.

Admission to all bachelors' and masters' except to that of doctoral programmes of the University are made in the beginning of the first semester of the academic year. However, the Dean concerned, with the approval of the Academic Council, may commence a programme from the beginning of any semester. The admissions to doctoral programmes are made in the second semester. All the admissions are based on entrance tests except those that are mentioned in the prospectus for that year.

The number of seats in each programme for the academic year is decided by the Academic Council. Advertisement for admission to various programmes appears in the newspapers as well as displayed on the website of the University, *www.pau.edu*

## 2. Prospectus and Application Forms

The candidates can apply online on PAU website (www.pau.edu)

However, the NRIs shall have to get the application forms separately on payment of prescribed price at the Counter or by post. There are separate application forms for admission to undergraduate and postgraduate programmes. For postgraduate programmes, a candidate can appear in different tests as per his/her eligibility. A candidate is required to submit separate application form for each entrance test. The candidate should carefully study the admission rules and make sure that they fulfill the prescribed qualifications. The University will not pay travelling or other allowances for entrance test/counseling/interview for admission.

The prospectus and application form can also be downloaded from PAU website.

## 3. Reservations

Reservation for various categories of candidates shall be as under:

**(A) Undergraduate Programmes except Diploma Courses**

a. Candidates qualifying All-India Entrance Examinations for Admission

   Undergraduate CUET (ICAR-UG) conducted by NTA — 20%

b. Nominees from Foreign Countries (against additional seats)

c. The remaining seats in all these programmes shall be filled up from amongst the candidates who are residents of Punjab State or Union Territory of Chandigarh.

d. NRI/OCI candidates (against additional seats)

   i) B.Sc. (Hons) Agriculture 4-year — 5 Seats

   ii) B.Sc. (Hons) Horticulture 4-year — 5 Seats

   iii) B.Tech (Agril. Engg) 4-year — 8 Seats

   iv) B.Sc. (Hons) Community Science 4-year — 5 Seats

**(B) Masters' Programmes**

a. Candidates qualifying All-India Entrance Examinations for Admission

   – Postgraduate (AIEEA-PG) conducted by NTA — 30%

b. Nominees from Foreign Countries (against additional seats)

c. The remaining seats in all these programmes shall be filled up from amongst the candidates who are residents of Punjab State or Union Territory of Chandigarh. Admission for the M.Sc. Biotechnology seats (10 additional seats) to be filled through GAT_B done on All-India basis.

d. NRI/OCI candidates (except Self-supporting programmes) (against additional seats)

| | | |
|---|---|---|
| i) | College of Agriculture (not more than two seats in any discipline) | 5 Seats |
| ii) | College of Horticulture & Forestry | 2 Seats |
| iii) | College of Agricultural Engineering & Technology | 2 Seats |
| iv) | College of Basic Sciences & Humanities | 2 Seats |
| v) | College of Community Science | 2 Seats |
| vi) | MBA (Agribusiness) (against additional seats) | 5 Seats |
| vii) | MBA Programme (against additional seats) | 10 Seats |

**(C) Ph.D. Programmes**

a. Candidates qualifying All-India Competitive Examination AICE-JRF/SRF (Ph.D.) conducted by NTA 30%

b. Nominees from foreign countries (against additional seats)

c. The admission to Ph.D. programme shall be on All-India basis.

d. The in-service candidates from PAU or sponsored by other Institutes are not required to appearin the entrance test for admission to Ph.D. programme and their candidature in general category will not be considered. 20% seats (minimum one seat in each discipline shall be reserved) for inservice candidates of PAU on the basis of their seniority (only the senior most in-service candidates of a particular discipline will be considered for admission to Ph.D. programme as an in-service candidate) and the inservice candidates other than from PAU will be admitted against additional seats. The minimum qualifications for admission to Ph.D. programme for in-service candidate will remain the same.

e. In Ph.D. programme, 25% seats (subject wise) for SC/ST and 10% seats (college wise) for BC candidates shall be reserved.

**(D) MBA programme/M.Tech. Remote Sensing & Geographic InformationSystem and Self Supporting Programme**

- In MBA programme/M.Tech. Remote Sensing & Geographic Information System, 85% seats arefilled from candidates with state domicile and 15% from other states.
- In Self Supporting Programme, 15% additional seats for the candidates of other states.

**Reservation for different categories**

Within the seats meant for Punjab State and Union Territory of Chandigarh, the reservation for different categories in all Undergraduate and Masters' programmes shall be as under:

| | |
|---|---|
| (a) Scheduled Caste/Scheduled Tribe (SC/ST) | 25% |
| (b) Backward Class (BC)<br>(The Other Backward Class (OBC) for the purpose of reservation would comprise the castes and communities which have been notified or will be notified by the State Government from time to time as backward) | 10% |
| (c) Outstanding Sportspersons (all Undergraduate programmes and Masters' programmes but in Masters' programmes, reservation shall be college-wise, subject to a maximum of one seat in one subject) (SP against additional seats) | 5% |
| (d) Freedom Fighters, their dependents and legally adopted children of such parents who do not have their own children (FF) | 2% |

| | |
|---|---|
| (e) Children of in-service/ex-service armed forces/CRP/BSF Officers/ Officials(including officials who died during their service)/Children/Widows of Para- military forces personnel, Punjab Police, PAP and Punjab Home Guards killed or disabled in action to the extent of 50% or more and wards of Punjab Policemen decorated with Gallantry Medals (reservation shall be college wise) (AF) | 2% |
| (f) (i) Children of the families of persons killed as a result of terrorist violence or during operation by security forces acting in aid of civil power and/or children of innocent civilians who have sustained 100% disability in terrorist violence or during operation by security forces acting in aid of civil power<br>Children of persons killed/100% physically disabled in November 1984 riots and internal/ external migrants<br>Children of army deserters killed/100% physically disabled | (TA)<br>2% |
| ( g) Persons with disability (DP) (with Benchmark disabilities) | 5% |
| (h) Tsunami affected persons (TSA) | 1% |

**Note:**

1. The candidates claiming reservation under category (a), (b) and (d) to (h), above shall have to submit a certificate issued by the competent authority prescribed by the Govt. of Punjab on prescribed proforma given in the prospectus. (see Annexure)
2. Where the share of a particular reserved category comes to more than 0.5, at least one candidate shall be admitted from that category.
3. 5% seats (additional) faculty-wise, at least one seat in each of undergraduate and postgraduate programmes are reserved for Kashmiri Migrants/ Kashmiri Pandits/ Kashmiri Hindu families (Non-Migrants). They are required to appear in the entrance examination for admission wherever applicable. The minimum percentage of marks in the qualifying examination is reduced by 10% for determining the eligibility to appear in the entrance examination. Domicile for only Kashmiri Migrants are waived off. However they are required to produce a certificate given by the Deputy Commissioner of the concerned district that they belong to the class of Kashmiri Migrants. Kashmiri Pandits/ Kashmiri Hindu families (Non-Migrants) living in the Kashmir Valley need Domicile Certificate.
4. Two seats in B.Sc. (Hons) Agriculture are reserved for the nominees of militancy infested area of J&K against additional seats. The admission will be made on the basis of recommendations made by the Chief Secretary of the J&K and after ensuring that the candidates recommended fulfil the minimum prescribed requirements for admission.
5. Two seats in B.Sc. (Hons) Agriculture 4-year programme are reserved for J&K students under Prime Minister's Special Scholarship Scheme (PMSSS).
6. The admission of sportspersons under category (c) shall be governed by criteria at Annexure A to D available in PAU Prospectus.
7. Unfilled seats from the reserved categories shall be offered to candidates competing on open merit basis.
8. If seats meant for ICAR nominees in UG and PG programmes remains vacant, these will be filled from the general quota.
9. The reservation in Masters' programmes for BC/AF/FF/TA/DP/TSA shall be college-wise subject to maximum one seat in one subject.
10. The reservation in Ph.D. programmes for BC category shall be college wise with maximum of one seat in one discipline by creating additional seat, if needed.
11. Five seats (two seats for College of Agriculture and one each for College of Horticulture & Forestry, College of Agricultural Engineering & Technology and College of Community Science) will be allocated for in-service candidates against the existing seat(s) in Masters' Programmes. In College of Agriculture, not more than one candidate will be admitted in one subject. These candidates will have to appear in the relevant entrance

test to be conducted for Masters' programme by this university. Themerit list of in-service candidates will be prepared separately.

12. The candidate seeking admission in PAU in various programmes except Ph.D. are required to furnish Residence Certificate as per instructions/guidelines issued by the Govt. of Punjab, Department of Personnel and Administration Reforms (Personnel Policies II Branch), Chandigarh vide their letter No.1/3/95-3PPII/9619 dated 6.6.1996. Specimen formats of Residence Certificate for various categories mentioned in the above letter are available in the Prospectus. The candidates should furnish certificate as applicable to them.
13. 2% additional seats are reserved for the wards of the PAU employees in all the UG programmes as follows:
    a) 1% for the wards of PAU employees posted at main campus
    b) 1% for wards of PAU employees
    - who are currently posted at outstation, subject to the condition that they will give an under-taking to serve at least for 5 years at outstation.

    OR

    - who have already served at least for five years at outstation on regular position and are now posted anywhere. Period spent on deputation/study leave/EOL will not be counted.

      The wards of faculty/staff who fulfills the above conditions may fill both the choices i.e. incampus and out campus (who have served outstation and also on main campus)

    c) If any seat remains vacant under 13 (a), it will be offered to candidate from 13 (b) andvice-versa.
14. Any seat remaining vacant among the existing seats due to the non availability of the applicant, who do not qualify the eligibility criteria under any category will be made available to general category. Additional seats for any specific category will not be made available to general category.

## 4. Schedule of Admission

Admission to all undergraduate and Master's programmes of the university shall be made in the beginning of the first semester and to Ph.D. programme in the beginning of the second semester of the academic year. No admission will be made in the subsequent semester. The admission notice is generally published in the leading newspapers in April except for Ph.D. programmes which is published in October. No separate counselling/interview letters will be issued. The candidates must personally attend the counselling/document verification/ interview.

## 5. Eligibility Criteria

Eligibility requirements for various undergraduate programmes

**College of Agriculture**

| **Programme** | **Entrance Test** | **Eligibility** |
|---|---|---|
| **Diploma Course** | | |
| Diploma in Agriculture 2-year at PAU, Ludhiana | No Entrance Test | Matric |
| **Undergraduate Programmes** | | |
| B.Sc. Agri (Hons) - 4 year † | CET | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/ Agriculture /Two year Diploma in Agriculture with at least 50% marks in aggregate |
| B.Tech. (Food Technology) -4 year* | CET | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/Agriculture/Certificate course in Food Processing and Preservation from SLIET, Longowal with at least 50% marks in aggregate. |

| | | |
|---|---|---|
| B.Tech. (Biotechnology) - 4 year* | CET | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/ Agriculture with at least 50% marks in aggregate. |
| B.Sc. (Hons) Agriculture 2+4 year at Institute of Agriculture, Bathinda and Gurdaspur | AAT | Matriculation or equivalent with at least 65% marks in aggregate with Math and Science as compulsory subjects. |

*** Self-supporting Programme**

i) The students of B.Sc. (Hons) Agriculture 2+4 year programme will study the basic courses of 10+2 (Medical stream) at Institutes of Agriculture (IOA) at Bathinda and Gurdaspur. The students will shift to B.Sc. (Hons) Agriculture programme at PAU, Ludhiana, only after clearing all their courses at IOA, Bathinda and Gurdaspur.

ii) The students admitted in B.Sc. (Hons) Agriculture 2+4 year through AAT with 10+2 qualification will not be allowed any exemption of courses of 10+2 standard.

iii) The shifting of students of B.Sc. (Hons) Agriculture 2+4 year programme will not be allowed from Institute of Agriculture, Gurdaspur to Institute of Agriculture, Bathinda and vice versa.

iv) The first two years of B.Sc. (Hons) Agriculture 2+4 year degree programme will be equivalent to 10+2 (Medical stream) standard of Punjab School Education Board, Mohali. The students after completion of B.Sc. (Hons) Agriculture programme will be issued certificates of 10+2 (equivalent) and B.Sc. (Hons) Agriculture separately.

**Postgraduate Programmes**

The minimum qualifications for admission to Masters' programme (other than in-service candidates) shall be an OCPA of 6.00 out of 10.00 or 60% marks or equivalent at the graduation level.

| Programme | Entrance Test | Eligibility |
|---|---|---|
| Agricultural Extension Education | MET-Agri. | B.Sc. Agri./B.Sc. Agri. (Hons)/B.Sc. (Hons) Agri./B.Sc. Hort./ B.Sc. (Hons) Hort./B.Sc. Forestry/B.Sc. (Hons) Forestry/B.Sc. Biotech. (Hons) 4-year/ B.Tech. Biotech. 4-year/B.Tech. Food Tech.4-year/ B.Sc. Agril. Marketing & Co-operation/B.Sc. ( Hons) Agril. Marketing & Co-operation |
| Agricultural Meteorology | MET-Agri. | B.Sc. Agri./B.Sc. Agri. (Hons) /B.Sc. (Hons) Agri./B.Sc. Hort./B.Sc.(Hons) Hort./B.Sc. Forestry/B.Sc. (Hons) Forestry |
| Agronomy | MET-Agri. | B.Sc. Agri./B.Sc. Agri. (Hons)/B.Sc. (Hons) Agri. |
| Entomology | MET-Agri. | B.Sc. Agri./ B.Sc. Agri. (Hons)/ B.Sc.(Hons) Agri. / B.Sc. Hort./ B.Sc.(Hons) Hort./B.Sc. Forestry/B.Sc.(Hons) Forestry/B.Sc. Biotech. (Hons) 4-year/ B.Tech. Biotech. 4-year/B.Sc. Sericulture/B.Sc.(Hons) Sericulture |
| M.Tech. Food Processing Technology | MET-Agri. | B.Sc. Agri./ B.Sc Agri.(Hons) /B.Sc. (Hons) Agri. /B.Sc. Hort./ B.Sc.(Hons) Hort./B. Tech. Food Technology 4-year/B.Sc. Food Science 4-year/ B.Sc. Food Technology 4-year/B.Sc. Home Science 4-year/ B.Sc. (Hons) Community Science/B.Sc. Nutrition and Dietetics 4-year/B.Sc. (Hons) Food Nutrition and Dietetics 4-year/B. Tech. Dairy Technology |
| Genetics & Plant Breeding | MET-Agri. | B.Sc. Agri./ B.Sc Agri.(Hons) /B.Sc. (Hons) Agri./B.Sc. Hort./ B.Sc.(Hons) Hort./B.Sc. Forestry/B.Sc.(Hons) Forestry/B.Sc. Biotech. (Hons) 4-year/ B.Tech. Biotech.4-year |

| | | |
|---|---|---|
| Molecular Biology & Biotechnology | MET-Agri. | B.Sc. Agri./ B.Sc Agri.(Hons) /B.Sc. (Hons) Agri./B. Sc.Hort/B.Sc. (Hons) Hort/B.Sc. Forestry/B.Sc. (Hons) For- estry |
| Plant Pathology | MET-Agri. | B.Sc. Agri./ B.Sc Agri. (Hons) /B.Sc. (Hons) Agri. /B.Sc. Hort./ B.Sc.(Hons) Hort./B.Sc. Forestry/B.Sc. (Hons) For- estry / B.Sc. Biotech. (Hons) 4-year/ B.Tech. Biotech. 4-year |
| Soil Science | MET-Agri. | B.Sc. Agri./ B.Sc Agri.(Hons) /B.Sc. (Hons) Agri. /B.Sc. Hort./ B.Sc.(Hons) Hort./B.Sc. Forestry/B.Sc. (Hons)For- estry |
| Molecular Biology & Biotechnology | MET-MBB | B.Sc. Biotech. (Hons) 4-year/ B.Sc. Biotech 4-year B.Tech. Biotech.4-year/B. Sc Molecular Biology 4-year/ B.Sc. Agri./ B.Sc. Agri.(Hons) /B.Sc. (Hons) Agri. /B.Sc. Hort./ B.Sc.(Hons) Hort./B.Sc. Forestry/B. Sc.(Hons) Forestry |
| Biotechnology | Graduate Aptitude Test Biotechnology (GATB) conducted by the Regional Centre for Bio- technology (RC-B)-through NTA on behalf of the Department of Biotechnology (DBT), Government of India | B.Sc. Biotech. (Hons) 4-year/ B.Sc. Bio- tech 4-year B.Tech. Biotech.4-year/B. Sc Molecular Biol- ogy 4-year/ B.Sc. Agri./ B.Sc. Agri. (Hons) /B.Sc. (Hons) Agri. /B.Sc. Hort./ B.Sc.(Hons) Hort./B. Sc. Forestry/B. Sc.(Hons) Forestry |

4 seats in M.Sc. Molecular Biology and Biotechnology will be filled through MET-Agri Test.

**For in-service candidates**: The minimum qualifications for admission to Masters' programmes for in-service candidates in the faculty of agriculture in the respective discipline shall be an OCPA of 5.50 out of 10.00 or 55% aggregate marks or equivalent at graduation level with at least 5 years professional experience (after completion of Bachelor's degree) at the minimum level of Agricultural Development Officer or equivalent on the last date of receipt of applications in Teaching/Research/Extension in any department of Punjab Government/ Union Territory of Chandigarh and other Semi- Govt. organization. The candidates who have experience on jobs lower than the Agricultural Development Officers and equivalent must possess minimum OCPA of 6.00 out of 10.00 or 60% marks at the graduation level. For admission under in-service category, only those applications shall be considered which are dulyforwarded by the Heads of the Departments/ Deans or Directors concerned, duly certified that during the study period, their lien will be retained against regular posts and on completion of their studies, they will join the said posts.

**Ph.D. Programmes**

The minimum qualifications for admission to Ph.D. programme (other than in-service candidates and ICAR nominees) shall be an OCPA of 7.00 out of 10.00 or 70% marks or equivalent at Master's levelland an OCPA of 6.00 out of 10.00 or 60% marks or equivalent at Bachelor's level.

| Programme | Entrance Test | Eligibility |
|---|---|---|
| Agricultural Extension Education | PET-Agri. | M.Sc. in Extension Education/ Agricultural Extension/Communication and B.Sc. Agri./ B.Sc. Agri. (Hons) / B.Sc. (Hons) Agri. / B.Sc. Hort./ B.Sc. (Hons) Hort./B.Sc. Forestry/B.Sc. (Hons)Forestry/B.Sc. Biotech. (Hons) 4-year/ B.Tech.Biotech. 4-year/B.Tech Food Tech.4- year/ B.Sc. Agril. Marketing & Co-operation/B.Sc. (Hons) Agril. Marketing & Co- operation |
| Agricultural Meteorology | PET-Agromet. | M.Sc. in Agricultural Meteorology/Agronomy/Agricultural Physics with specialization in Agricultural Meteorology and B.Sc. Agri./ B.Sc. Agri. (Hons) /B.Sc. (Hons) Agri. B.Sc. Hort./ B.Sc.(Hons) Hort./B.Sc. Forestry/B.Sc.(Hons) Forestry |
| Agronomy | PET-Agri. | M.Sc. In Agronomy and B.Sc. Agri./B.Sc.Agri. (Hons)/ B.Sc. (Hons) Agri. |
| Molecular Biology & Biotechnology | PET-MBB | M.Sc. in Biotechnology/ Molecular Biology and Biotechnology/ Agricultural Biotechnology/ Plant Breeding and Genetics/Genetics and Plant Breeding/Vegetable Science /Fruit Science/ Forestry/ Floriculture and Landscaping / Horticulture and B.Sc. Biotech. (Hons)/B.Sc. Biotech. 4-year/B. Tech. Biotech. / B.Sc. Agri. (Hons)/ B.Sc. (Hons) Agri. / B.Sc. Forestry / B.Sc. Hort./ B.Sc.(Hons) Hort./B. Sc. (Hons) Forestry |
| Entomology | PET-Agri. | M.Sc. in Entomology/Agricultural Entomology/Plant Protection with specialization in Entomology and B.Sc. Agri./ B.Sc. Agri. (Hons)/B. Sc. (Hons) Agri./ B.Sc. Hort./ B.Sc. (Hons) Hort./B. Sc. Forestry/B. Sc. (Hons) Forestry/B.Sc. Biotech. (Hons) 4-year/ B.Tech. Biotech.4-year/ B.Sc. Sericulture/B.Sc.(Hons) Sericulture |
| Food Processing Technology | PET-Agri. | M.Sc. in Food Technology/M.Tech. Food Technology/M.Tech. Dairy Technology and B.Sc. Agri./ B.Sc Agri.(Hons) /B.Sc. (Hons) Agri. B.Sc. Hort./ B.Sc.(Hons) Hort./B. Tech. Food Technology 4-year/B. Sc. Food Science 4-year / B.Sc. Food Technology 4-year/B.Sc. Home Science 4-year/ B.Sc. (Hons) Community Science/B.Sc. Nutrition and Dietetics 4-year/B.Sc. (Hons) Food Nutrition and Dietetics 4-year/B. Tech. Dairy Technology |
| Genetics & Plant Breeding | PET-Agri. | M.Sc. in Plant Breeding/ Plant Breeding & Genetics /Genetics / Genetics & Plant Breeding and B.Sc. Agri./ B.Sc Agri.(Hons) /B.Sc. (Hons) Agri. /B.Sc. Hort./ B.Sc.(Hons) Hort./ B.Sc.Forestry /B.Sc. (Hons) Forestry / B.Sc. Biotech. (Hons) 4-year/ B.Tech. Biotech. 4-year |
| Plant Pathology | PET-Agri. | M,Sc. in Plant Pathology/ Plant Protection with specialization in Plant Pathology and B.Sc. Agri./ B.Sc Agri.(Hons) /B.Sc. (Hons) Agri./B.Sc. Hort./ B.Sc.(Hons) Hort./B.Sc.Forestry/B.Sc.(Hons) For- estry / B.Sc. Biotech. (Hons) 4-year/ B.Tech. Biotech. 4-year |
| Soil Science | PET-Agri. | M.Sc in Soil Science and B.Sc. Agri./ B.Sc Agri. (Hons) /B.Sc. (Hons) Agri. /B.Sc. Hort./ B.Sc. (Hons)Hort./B.Sc.Forestry/B.Sc.(Hons) For- estry |

**For in-service candidates**

The minimum qualifications for admission to Ph.D. programme for in-service and ICAR candidates in the faculty of Agriculture in the above mentioned disciplines shall be an OCPA of 6.50 out of 10.00 or equivalent at the M.Sc. level and OCPA of 5.50 out of 10.00 or an OGPA of 2.42 out of 4.00 or equivalent at the Bachelor's level. For the purpose of admission to Ph.D. programme, an in-service candidate shall be an employee of PAU or Punjab Govt. or Union Territory of Chandigarh having at least five years experience of Teaching/ Research/ Extension out of which at least three years should be after obtaining M.Sc. degree on the last date of receipt of applications.

**PAU College of Agriculture, Ballowal Saunkhri**

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| **Undergraduate Programmes** | | |
| B.Sc. (Hons) Agriculture<br>4 - year | BSET | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/ Agriculture/ Two year Diploma in Agriculture with at least 50% marks in aggregate |

**College of Horticulture & Forestry**

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| **Undergraduate Programmes** | | |
| B.Sc. (Hons) Horti-culture 4 - year | CET | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/ Agriculture/ Two year Diploma in Agriculture with atleast 50% marks in aggregate |

**Postgraduate Programmes**

The minimum qualifications for admission to Masters' programme (other than in-service candidates) shall be an OCPA of 6.00 out of 10.00 or 60% marks or equivalent at the graduation level.

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Horticulture (Fruit Science) | MET-Agri. | B.Sc. Hort./ B.Sc. (Hons) Hort / B.Sc. Agri./B.Sc. Agri. (Hons) / B.Sc. (Hons) Agri./B.Sc. Biotech. (Hons) 4 - year/ B.Tech. Bio-tech. 4 - year |
| Horticulture (Vegetable Science) | MET-Agri. | |
| Horticulture (Floriculture & Landscaping) | MET-Agri. | |
| Forestry (Silviculture & Agroforestry) | MET-Agri. | B.Sc. Forestry / B.Sc. (Hons) Forestry B.Sc. Hort. / B.Sc. (Hons) Hort./ B.Sc. Agri./ B.Sc. Agri. (Hons)/ B.Sc. (Hons) Agri. / B.Sc. Biotech. (Hons) 4 - year/ B.Tech. Biotech. 4 - year |

**For in-service candidates**: The minimum qualifications for admission to Masters' programmes for in-service candidates in the faculty of Horticulture in the respective discipline shall be an OCPA of 5.50 out of 10.00 or 55% aggregate marks at graduation level or equivalent with at least 5 years professional experience (after completion of Bachelor's degree) at the minimum level of Agricultural Development Officer or equivalent on the last date of receipt of applications in Teaching/Research/Extension in any department of Punjab Government/ Union Territory of Chandigarh and other Semi- Govt. organization. The candidates who have experience on jobs lower than the Agricultural Development Officers and equivalent must possess minimum OCPA of 6.00 out of 10.00 or 60% marks at the graduation level. For admission under in-service category, only those applications shall be considered which are duly forwarded by the Heads of the Departments/ Deans or Directors concerned, duly certified that during the study period, their lien will be retained against regular posts and on completion of their studies, they will join the said posts.

**Ph.D. programmes**

The minimum qualifications for admission to Ph.D. programme (other than in-service candidates and ICAR nominees) shall be an OCPA of 7.00 out of 10.00 or 70% marks or equivalent at Master's level and an OCPAof 6.00 out of 10.00 or 60% marks or equivalent at Bachelor's level.

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Horticulture (Fruit Science) | P E T - Agri | M.Sc. in Horticulture (Fruit Science) / M.Sc. Fruit Science/ M.Sc. Pomology/ M.Sc. in Horticulture with specialization in Fruit Science and B.Sc. Agri /B.Sc. Agri. (Hons)/B.Sc. (Hons) Agri. / B.Sc. Hort./ B.Sc. (Hons) Hort / B.Sc. Biotech (Hons) 4-year/ B.Tech. Biotech 4-year |
| Horticulture (Vegetable Science) | P E T - Agri | M.Sc. in Horticulture (Vegetable Science) / M.Sc. Vegetable Science/ M.Sc. Olericulture / M.Sc. in Horticulture with specialization in Vegetable Science and B.Sc. Agri /B.Sc. Agri. (Hons) / B.Sc. (Hons) Agri./ B.Sc. Hort./ B.Sc. (Hons) Hort / B.Sc. Biotech (Hons) 4-year/ B.Tech Biotech 4-year |
| Horticulture (Floriculture & Landscaping | P E T - Agri | M.Sc. in Horticulture (Floriculture & Landscaping) / M.Sc. in Floriculture & Landscaping/ M.Sc. in Floriculture & Landscape Architecture / M.Sc. in Agriculture or Horticulture with specialization in Floriculture & Land- scape Architecture and B.Sc. Agri /B.Sc. Agri. (Hons) / B.Sc. (Hons) Agri./ B.Sc. Hort./ B.Sc. (Hons) Hort / B.Sc. Biotech (Hons) 4-year/ B.Tech. Bio- tech 4-year |

**For in-service candidates**

The minimum qualifications for admission to Ph.D. programme for in-service candidates and ICAR candidates in the faculty of Horticulture in the above mentioned disciplines shall be an OCPA of 6.50 out of 10.00 or equivalent at the M.Sc. level and OCPA of 5.50 out of 10.00 or an OCPA of 2.42 out of 4.00 or equivalent at the Bachelor's level). For the purpose of admission to Ph.D. programme, an in-service candidate shall be an employee of PAU or Punjab Govt. or Union Territory of Chandigarh having at least five years experience of Teaching/Research/Extension out of which at least three years should be after obtaining M.Sc. degree on the last date of receipt of applications.

**College of Agricultural Engineering & Technology**

**Undergraduate Programmes**

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| B.Tech. (Agril. Engg.) 4-year | CET | 10+2 (Non-medical) or equivalent with at least 50% marks in aggregate |

**Postgraduate Programmes - M.Tech. / MCA**

The minimum qualifications for admission to Master's programmes (other than in-service candidates) shall be an OCPA of 6.00 out of 10.00 or 60% marks or equivalent at the graduation level as shown against the respective discipline(s).

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Civil Engineering (Hydrology & Water Resources Engg./ Structural Engg.) | MET-CE | Bachelor of Engineering or Technology in Civil/ Agril. Engg. |
| Computer Science & Engineering | MET-CSE | Bachelor of Engineering or Technology in Computer Science/ Electronics/Electrical Engg./ In- formation Tech. |

| | | |
|---|---|---|
| Farm Machinery & Power Engineering | MET-AE | Bachelor of Engineering or Technology in Agril. Engg./ Mechanical / Production Engg. |
| Processing & Food Engineering | MET-AE | Bachelor of Engineering or Technology in Agril. Engg./ Agric .& Food Engg./ Mechanical/ Civil/ Elect. /Electronics/ Food Engg. /Process and Food Engg. / Chemical Engg./Food Tech./B.Sc. Food Tech. (Hons)/ B.Tech. Food Tech./ Dairy Technology |
| Irrigation and Drainage Engineering | MET-AE | Bachelor of Engineering or Technology in Agril. Engg./Civil Engg. |
| Soil & Water Conservation Engineering | MET-AE | Bachelor of Engineering or Technology in Agril. Engg./ Civil Engg. |
| Master of Computer Applications (MCA) | No Entrance Test | BCA / Bachelor Degree Computer Science Engineering/ Information Technology with 50% marks |
| Remote Sensing & Geographic Information System (GIS) | No Entrance Test | Bachelor of Engineering or Technology in Agricultural Engineering/Aerospace Engineering/ Information Technology /Computer Science Engg/ Electronics & Communication/ Civil Engg/ Water Resources Engg/ Mining Engg/ Mineral Engg/ Petroleum Engg or Master's degree in Environmental Sciences/Earth Sciences/ Remote Sensing/ Geo-informatics/ Geography/ Geology/ Physics/ Mathematics/ Computer Sciences/ Information Technology/ Agricultural Sciences/ Forestry/B.Sc. (Hons) Agri 4 year |

**For in-service candidates**

The minimum qualifications for admission to Masters' programmes for in-service candidates in the faculty of Agricultural Engineering in the respective discipline shall be an OCPA of 5.50 out of 10.00 or 55% aggregate marks or equivalent at the graduation level with at least 5 years professional experience (after completion of Bachelor's degree) at the minimum level of Junior Engineer or equivalent on the last date of receipt of applications in Teaching/Research/Extension in any department of Punjab Government/Union Territory of Chandigarh and other Semi Govt. Organization.

The candidates who have experience on jobs lower than the Junior Engineer or equivalent must possess minimum OCPA of 6.00 out of 10.00 or 60% marks at the graduation level.

For admission under in-service category, only those applications shall be considered which are duly forwarded by the Heads of the Departments/ Deans or Directors concerned, duly certified that during the study period their lien will be retained against regular posts and on completion of their studies, they will join the said posts.

**Ph.D. Programmes**

The minimum qualifications for admission to Ph.D. programme (other than in-service candidates and ICAR nominees) under the faculty shall be an OCPA of 7.00 out of 10.00 or 70% marks or equivalent in M.Tech. and an OCPA of 6.00 out of 10.00 or 60% marks or equivalent at Bachelor's level.

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Farm Machinery & Power Engineering | PET-AE | Master's Degree in Agricultural Engineering/ Mechanical Engineering with specialization in Farm Machinery and Power / Renewable Energy Engineering |
| Processing & Food Engineering | PET-AE | Master's Degree in Agricultural Engineering with specialization in Agricultural Processing Engineering/ Processing and Food Engineering/ Food Process Engineering/Dairy Engineering/ Post Harvest Technology (with specialization in Post Harvest Engineering and Technology)/ Renewal Energy Engineering |
| Renewable Energy Engineering | PET-REE | Master's Degree in Agricultural Engineering with specialization in Renewable Energy/Farm Machinery and Power Engineering/ Processing and Food Engineering/Soil and Water Conservation Engineering/ Soil and Water Engineering / Irrigation and Drainage Engineering/ M.Sc. in Biochemistry / Microbiology |
| Irrigation & Drainage Engineering | PET-AE | Master's Degree in Agricultural Engineering with specialization in Soil and Water Engineering/Soil and water Conservation Engineering / Irrigation and Drainage Engineering/ Water Resources / Water Science and Technology |
| Soil & Water Conservation Engineering | PET-AE | Master's degree in Agricultural Engineering with specialization in Soil and Water Engineering / Soil and water Conservation Engineering / Irrigation and Drainage Engineering/ Water Resources / Water Science and Technology |

**For in service candidates**

The minimum qualifications for admission to Ph.D. programme for in-service and ICAR candidates in the faculty of Agricultural Engg & Technology shall be an OCPA of 6.50 out of 10.00 or equivalent at the M.Tech. level and OCPA of 5.50 out of 10.00 or an OGPA of 2.42 out of 4.00 or equivalent at the Bachelor's level. For the purpose of admission to Ph.D. programme, an in-service candidate shall be an employee of PAU or Punjab Govt. or Union Territory of Chandigarh having at least five years experience of Teaching/Research/Extension out of which atleast three years should be after obtaining M.Tech. degree on the last date of receipt of applications.

**College of Basic Sciences & Humanities**
**Undergraduate Programmes**

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| B.Sc. (Hons) Agribusiness Management 4-year | CET | 10+2 or equivalent with Physics, Chemistry and Mathematics/Biology/Agriculture with at least 50% marks in aggregate. |

**5– year Integrated M.Sc. (Hons) Programmes**

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Biochemistry | CET | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/Agriculture with at least 50% marks in aggregate |
| Botany | CET | |
| Chemistry | CET | |
| Microbiology | CET | |
| Physics | CET | |
| Zoology | CET | |

**Postgraduate Programmes – M.Sc./MBA/MJMC/MBA (Agribusiness)**

The minimum qualifications for admission to Masters' programmes (other than in-service candidates) shall be an OCPA of 6.00 out of 10.00 or 60% marks 'or' equivalent except for M.Sc. Sociology and Master in Journalism and Mass Communication for which an OCPA of 5.50 out of 10.00 or 55% marks at the Graduation level.

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Agril. Economics | MET-Agri | B.Sc.Agri./Horticulture/Agril. Marketing & Co-operation/ Forestry or B.Sc. (Hons) Agriculture/ Horticulture/ Agril. Marketing & Co-operation or B.Sc. (Hons) Agri./ Forestry or B.Sc. Agri. (Hons) / B.Sc. (Hons) Agribusiness Management/B.Sc. Agribusiness Management |
| Biochemistry | MET-Basic Sciences | B.Sc. Medical/B.Sc. (Hons) with any Biological Science/ B.Sc. Biochemistry/ B.Sc. Agri./B.Sc. Agri. (Hons)/B.Sc. (Hons) Agri./B. Sc. Biotech. (Hons)/B.Tech. Biotech/B.Sc. Food Tech./B.Tech. Food Tech./B.Sc. Hort./B.Sc. (Hons) Hort./B.Sc. Forestry/B.Sc. (Hons) Forestry |
| Botany | MET-Basic Sciences | B.Sc. Medical/B.Sc. (Hons) with Botany/ B.Sc. Botany/B. Sc. Agri./B. Sc. Agri. (Hons) /B.Sc. (Hons) Agri.)/ B.Sc. Biotech. (Hons)/ B.Tech. Biotech./ B.Sc. Hort./B.Sc. (Hons) Hort./B.Sc. Forestry/ B.Sc. (Hons) Forestry |
| Chemistry | MET-Chemistry | B.Sc./B.Sc. (Hons) with Chemistry/ B.Sc. Chemistry |
| Mathematics | MET-Math | B.A./B.Sc. or equivalent with Mathematics |
| Microbiology | MET-Basic Sciences | B.Sc. Medical/B.Sc. (Hons) with any Biological Science/B. Sc. Microbiology/B. Sc. Agri./B.Sc.Agri. (Hons)/B.Sc. (Hons) Agri./B. Sc. Biotech (Hons)/B.Tech. Biotech/B.Sc. Food Tech./B.Tech. Food Tech./B.Sc. Hort./ B.Sc. (Hons) Hort /B.Sc. Forestry/ B.Sc. (Hons) Forestry. |
| Physics | MET-Physics | B.Sc. with Physics and Math/B.Sc. (Hons) with Physics |
| Sociology | MET-Sociology | B.Sc. Agri. /B.Sc. Agri. (Hons)/ B.Sc. (Hons) Agri./B.Sc. Home Science/B.Sc. Home Science (Hons)/ B.Sc. (Hons) Community Science/B.A. with Sociology or Economics. |
| Zoology | | B.Sc. Medical/B.Sc.(Hons) with Zoology/ B.Sc. Zoology/B. Sc. Fisheries/B.Sc. Agri./B.Sc. Agri(Hons)/B.Sc. (Hons) Agri./B.Sc. Biotech. (Hons)/B.Tech. Biotech |

| | | |
|---|---|---|
| Statistics | | B.Sc. (Non-Medical)/ B.A. with Mathematics/ B.Sc. with Statistics/ B.Sc. in Computer Science, Statistics and Mathematics |
| MBA | MET-MBA | Graduate in any discipline |
| MBA (Agribusiness) | MET-Agri. Busi- ness | Graduates in any field of Agricultural Sciences or allied subjects [Agriculture/Horticulture/ Food Science and Technology/Biotech./ Dairy Technology/Dairy Sciences/ Fisheries Sciences/ Forestry/ Agri- Engineering / Veterinary Sciences/ Agri-Business / Commercial Agriculture/ Sericulture/B.Sc (Hons) Community Science/ B.Sc. Home Science 4 year duration/ B.Sc. Agril. Marketing & Co-operation] |
| Master in Journalism and Mass Communication (MJMC) | MET-Jlsm | Graduate in any discipline/ second class Master's degree/ second class graduate with Diploma in Journalism |

**Ph.D. Programmes**

The minimum qualifications for admission to Ph.D. programme (other than in-service candidates and ICAR nominees) in the faculty of Basic Sciences & Humanities shall be an OCPA of 7.00 out of 10.00 or 70% marks or equivalent at the M.Sc. and OCPA of 6.00 out of 10.00 or 60% marks or equivalent at Bachelor's level.

| **Programmes** | **Entrance Test** | **Eligibility** |
|---|---|---|
| Agricultural Economics | PET-Agri. | M.Sc. in Agricultural Economics/M.Sc. Dairy Economics |
| Biochemistry | PET-Basic Sciences | M.Sc. Plant Biochemistry/Biochemistry |
| Botany | PET-Basic Sciences | M.Sc. in Botany/Plant Physiology/Crop Physiology |
| Business Administration | PET-Basic Sciences | Master's Degree in Business Administration/ Commerce |
| Chemistry | PET-Basic Sciences | M.Sc. in Chemistry |
| Microbiology | PET-Basic Sciences | M.Sc. Microbiology |
| Sociology | PET-Agri. | M.Sc. in Sociology/M.A. in Sociology |
| Zoology | PET-Basic Sciences | M.Sc. in Zoology |

**For in-service candidates**

The minimum qualifications for admission to Ph.D. programme for in-service and ICAR candidates in the faculty of Basic Sciences & Humanities shall be an OCPA of 6.50 out of 10.00 or equivalent at the Master's level and OCPA of 5.50 out of 10.00 or an OGPA of 2.42 out of 4.00 or equivalent at the Bachelor's level. For the purpose of admission to Ph.D. programme, an in-service candidate shall be an employee of the PAU or Punjab Govt. or Union Territory of Chandigarh having at least five years experience of Teaching/Research/Extension out of which at least three years should be after obtaining M.Sc. degree on the last date of receipt of applications.

**College of Community Science**

**Undergraduate Programmes**

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| B.Sc. (Hons) Community Science 4 - year | No Entrance Test | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/ Agriculture/ Home Science with at least 50% marks in aggregate. |
| B.Sc. (Hons) Fashion Designing 4-year* | No Entrance Test | 10+2 or equivalent in any stream with atleast 50% marks in aggregate. |
| B.Sc. (Hons) Nutrition & Dietetics 4 – year | CET | 10+2 or equivalent with Physics, Chemistry and Mathematics/ Biology/ Agriculture/ Home Science with at least 50% marks in aggregate |
| **Certificate Courses** | | |
| Certificate Course in Early Childhood Care & Education 1-Year | No Entrance Test | 10+2 or equivalent in any stream with at least 50% marks in aggregate. |
| Certificate Course in Interior Design & Decoration 1-Year<br>*Self Supporting | No Entrance Test | |

**Postgraduate Programmes – M.Sc.**

The minimum qualification for admission to Masters' Programme (other than in-service candidate) shall be an OCPA of 6.00 out of 10.00 or 60% marks or equivalent at graduation level. The graduation degree should be of 4 year.

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Apparel & Textile Science | MET-Community Science | B.Sc. Home Science/B.Sc. (Hons) Home Science/B.Sc. (Hons) Community Science |
| Extension Education & Communication Management | MET-Community Science | |
| Human Development & Family Studies | MET-Community Science | |
| Resource Management & Consumer Science | MET-Community Science | |
| Food & Nutrition | MET-Community Science | B.Sc. Home Science/B.Sc. (Hons) Home Science/B. Sc. (Hons) Community Science/ B.Sc. Nutrition & Dietetics/B.Sc. (Hons) Nutrition & Dietetics |

**Ph.D. Programmes**

The minimum qualifications for admission to Ph.D. programme (other than in-service candidates and ICAR nominees) shall be an OCPA of 7.00 out of 10.00 or 70% marks or equivalent at Master's level in the respective discipline and 6.00 out of 10.00 or 60% marks or equivalent at graduation level. The graduation degree should be of 4-year (B.Sc. Home Science / B.Sc. (Hons) Home Science / B.Sc. (Hons) Community Science / B.Sc. (Hons) Nutrition & Dietetics).

| Programmes | Entrance Test | Eligibility |
|---|---|---|
| Apparel & Textile Science | PET-Community Science | M.Sc. in Apparel & Textile Science/ Clothing & Textiles/ Textile & Apparel Design |
| Resource Management & Consumer Science | PET-Community Science | M.Sc. in Family Resource Management / Home Management / Resource Management & Consumer Science |

| | | |
|---|---|---|
| Food & Nutrition | PET-Community Science | M.Sc. in Nutrition & Dietetics/ Food & Nutrition/Human Nutrition/Food Science & Technology /Dietetics |
| Extension Education & Communication Management | PET-Community Science | M.Sc Extension Education and Communication Management/ Home Science Education and Extension/Home Science Extension and Communication Management/ Home Science Extension Education |
| Human Development & Family Studies | PET-Community Science | M.Sc. in Human Development/ Child Development/Human Development & Family Studies |

**For in-service candidates**

The minimum qualifications for admission to Ph.D. programme for in-service and ICAR candidates in the faculty of Community Science in the respective discipline shall be an OCPA of 6.50 out of 10.00 or equivalent at the Master's level and OCPA of 5.50 out of 10.00 or an OGPA of 2.42 out of 4.00 or equivalent at the Bachelor's level. For the purpose of admission to Ph.D programme, an in-service candidate shall be an employee of PAU or Punjab Govt. or Union Territory of Chandigarh having at least five years experience of Teaching/Research/ Extension out of which at least three years should be after obtaining M.Sc. degree on the last date of receipt of applications.

**Important Notes:**

1. The condition of 50% and 65% marks will not be applicable to SC/ST candidates in all the programmes provided that the lower percentage prescribed does not fall below the minimum requirement for passing the qualifying examination (for undergraduate programmes only).
2. a)Two additional seats for B.Sc. (Hons) Agriculture 2+4 year programme reserved for the passouts of PAU Model High School, Kaoni, admitted through merit in AAT conducted by PAU.

   b) Two additional seats for B.Sc. (Hons) Community Science and B.Sc. (Hons) Nutrition & Dietetics for students who had studied in the PAU Model High School, Kaoni for minimum of 5-years and had also passed 10th class from the same school admitted through merit in CET conducted by PAU.
3. Boys are also eligible in all the programmes of College of Community Science.
4. Where admission is restricted to candidates who obtain certain minimum percentage of marks in the qualifying examination, the minimum percentage of marks may be reduced by 5% for candidates belonging to all other reserved categories, provided that the lower percentage pre-scribed does not fall below the minimum requirement for passing the qualifying examination.
5. 5-year Integrated M.Sc. (Hons) students are eligible for B.Sc. degree after 3 years if the student leaves the programme after fulfilling the requirements.
6. Candidates nominated by the ICAR through its various competitive examinations for admission to Bachelor, Master, Ph.D. degrees and M.Sc. Biotechnology students admitted through GATB will be admitted as such at PAU against their quota seats without their appearing in any entrance examination of the PAU and/or its interview/counselling, subject to verification of their original testimonials.
7. Students seeking admission in sports quota in undergraduate programmes should report for sports trial at 9:00 A.M. in the office of Director Students' Welfare one working day prior to date of counselling. The sports trial for all postgraduate programmes will be held on the day of counselling at 9:00 A.M. in the office of Director Student's Welfare.
8. Maximum credit load (including deficiency courses but excluding research credits) for international students on the rolls of the University shall be 50 credit hours and 40 credit hours for the Masters' and Ph.D. programmes, respectively.

## 6. Selection Procedure for Admissions

**A. Diploma/Certificate courses - 100% weightage on the basis of marks in the qualifying examination**

- Diploma in Agriculture 2-year
- Certificate Course in Early Childhood Care & Education 1-year
- Certificate Course in Interior Design & Decoration 1-year

**B. Undergraduate Programmes (AAT/CET/BSET)**

(i) The relative merit of candidates shall be determined on the basis of marks obtained in the entrance test (AAT/CET/BSET) except of sports persons and armed forces. The admission of sports persons shall be governed by criteria in PAU Prospectus . The choice of the programme will be obtained at the time of counselling.

**(ii) Undergraduate Programmes without Entrance Test - 100% weightage on the basis of marks in the qualifying examination**

- B.Sc. (Hons) Community Science 4 - year
- B.Sc. (Hons) Fashion Designing 4 - year

**C. MBA (Agribusiness) 2-year and MBA 2-year programmes**

The admission will be made on the basis of written test according to the following criteria:

| | **MBA (Agribusiness) 2- year programme** | | **MBA 2-year Programme** | |
|---|---|---|---|---|
| Written Test | Written communication ability | 25% | Verbal ability | 25% |
| | Numerical ability | 25% | Numerical ability | 25% |
| | Management aptitude | 25% | Management aptitude | 25% |
| | General Knowledge | 25% | General Knowledge | 25% |

**D. (a) Masters' Programmes with Entrance Test**

**Minimum percentage of marks required to be obtained in the entrance test to be called for Counselling/ Interview is 20% (with negative marking)**

The relative merit of candidates shall be determined on the basis of marks obtained in the entrance test except for sportspersons and armed forces. The admission of sportspersons shall be governed by criteria as in PAU Prospectus. The choice of subject of the candidates appearing in different entrance tests will be obtained at the time of counselling. For candidates seeking admission in Agriculture faculty and Community Science faculty, choice of subject will be same as filled up in the application form.

**(b) M.Tech. Remote Sensing and Geographic Information System 2-year and Master of Computer Applications Programme (without Entrance Test)**

i) Performance in Bachelor's degree 80%

ii) Performance in Interview 20%

**E. Ph.D. Programmes**

Minimum percentage of marks required to be obtained in the entrance test to be called for Counsel- ling/ Interview are 20% (with negative marking) in MCQ & 20% in subjective test individually.

**Basis of Admission**

i) Performance in the Entrance Examination 80% (60% MCQ + 20% subjective)

ii) Master's Research by Thesis & Quality of thesis 10% (No marks permissible for any project report)

iii) Interview 10%

**Note:**

i) If any graduate is awarded PG Scholarship (PGS) for M.Sc. by ICAR/CSIR/UGC or any other Government organization through competitive examination and if such a student seeks admission, he/she will be admitted in the University against additional seat without entrance test conducted by PAU in the concerned discipline, provided he/she fulfils the minimum requirements. The candidates from other States, who have won the above fellowship, will also be given admission against additional seats likewise.

ii) No candidate, who has received a stipend as an in-service candidate or who has done his/her M.Sc. on study leave, shall be admitted to Ph.D. programme unless he/she has completed the period of service he/she is bound to for the money received for his/her M.Sc. Such candidates, however, can be considered for admission if they return the money received prior to the last date for receipt of applications.

iii) The candidates, who are awarded fellowship by ICAR/CSIR/UGC through competitive examinations will be admitted to the Ph.D. programme of the University against additional seats in the concerned discipline without entrance test conducted by PAU. The candidates who have not been awarded Fellowship but cleared the examination conducted by ICAR/CSIR/UGC are required to appear in the entrance test and Interview conducted by PAU for admission to Ph.D. programme.

iv) The particulars of the candidates recommended by Selection Committee shall be placed before the Academic Council which will finalize the list of candidates to be admitted.

v) Marks given for the interview are for the purpose of selection only and are not to be considered for the grant of Fellowship

**Note:**

i) In case of tie in the merit list, a candidate getting higher percentage of marks in the qualifying examination shall be ranked higher in order of merit.

ii) In case of tie in percentage of marks in the qualifying examination also, the candidate senior in age shall be ranked higher in order of merit.

**7. Selection Notice**

- The list of qualified candidates are displayed on the PAU website only.
- The candidates selected on the basis of entrance test shall be required to deposit fee on their selection immediately after counselling/interview failing which the seat will be offered to the next candidate on merit on the same day.
- The waiting list for admission shall not be valid beyond the last date fixed for admission in that semester.
- The selected candidates from other than PAU shall have to submit medical fitness certificate to be obtained from the University Medical Officer within a week.
- The medical examination fees as per the Prospectus shall be charged from the candidates at the time of his/her medical examination.
- Any candidate found medically unfit, shall be entitled to refund of admission fees. The application for refund must be submitted within 14 days from the issue of selection notice.
- No admission in undergraduate and postgraduate programmes shall be made after the last date of admission.

## 8. International/NRI/OCI Students

**Rules and regulations for admission**

1. The candidates from foreign countries will be admitted in absentia against additional seats without appearing in the entrance test. Their admission will be regulated by the Indian Council of Agricultural Research, New Delhi. They will be admitted only if they have valid student visa. They must be declared medically fit after examination as per Annexure F by the Doctor authorized by the Indian Embassy in the country from where the student wishes to seek admission. They should have full medical insurance before their admission to any programme in the University.

2. Their suitability for admission to undergraduate programmes will be assessed by the committee consisting of the Dean of the college concerned (Chairperson), the Chairperson of Academic Affairs Committee and the Secretary of Board of Studies of the college concerned (members). For postgraduate programmes, the committee will consist of the Dean, Postgraduate Studies (Chairperson), the Dean of the college concerned (member) and the Head of the concerned department (member).
3. All foreign students, other than those sponsored by the Govt. of India with suitable fellowship such as scholarship under Colombo Plan, ITEC programme, General Cultural Scholarship and Cultural Technical Exchange, will be charged Institutional Economic Fee @ US $ 4000 per year per student. The students coming for study/training as nominees of SAARC countries will be charged US $ 2000 as Economic Fee per year per student. The institutional Economic Fee will be charged for the period prescribed for a particular programme. It will be for a period of two years for Masters' programme and three years for Ph.D. programme. However, they will have to deposit tuition fee and other usual charges for the period they remain enrolled in the programme.
4. A postgraduate foreign student who has completed his/her degree requirements except submission of thesis and wishes to register for thesis submission only, can do so without paying tuition fee, provided he/she must submit the rough draft of thesis by the last date of dropping the courses by postgraduate students prescribed for that particular semester, failing which the student will have to deposit full tuition fee and other charges for that semester also and if the student fails to submit the final thesis during that semester, he/she will have to register for the next semester and pay full fee.

**9. Regulations for NRI/OCI candidates**

1. The admission of NRI/OCI or their children/wards shall be made in the following programmes:
   i) B.Sc. (Hons) Agriculture 4-year
   ii) B.Sc. (Hons) Horticulture 4-year
   iii) B.Tech. (Agril Engg) 4-year
   iv) B.Sc. (Hons) Community Science 4-year
   v) MBA
   vi) MBA (Agribusiness)
   vii) M.Sc. / M.Tech

   The admission under this category will be given only to NRIs/OCI or their children/wards (in the wake of Honourable Supreme Court Judgement for Appeal (Civil) 5041 of 2005). The eligibility requirements for these programmes is the same as for general candidates. They are required to submit a copy of their certificate/transcript/marks sheet duly verified and certified by the Indian Embassy/High Commission in that country, stating that such examination is equivalent to the qualifying examination of Indian Universities. Alternatively, they may submit an application for obtaining the requisite equivalence certificate from the Registrar, PAU, by paying a fee of US$ 500 (non-refundable) through a Bank Draft in favour of Comptroller, PAU, payable at any scheduled Bank at Ludhiana. An NRI/OC/candidate who has cleared 10+2 examination from any recognized Indian School Board/University shall have to deposit the requisite processing fee of US $ 500/- or equivalent in Indian currency through Bank Draft favouring Comptroller, PAU, payable at any scheduled Bank at Ludhiana.
2. The admission of NRIs/OCI for the above programmes are primarily restricted to candidates having ancestral background in Punjab, provided they fulfill other conditions. However, in the event of vacant seats after adjusting them, other NRI/OC/candidates will be considered.
3. The NRI/OCI candidates educated and residing abroad seeking admission to various under-graduate programmes in PAU may be considered for admission without appearing in the entrance test of the university, provided they have passed 12th standard level examination with 50% marks in aggregate in the subjects of Physics, Chemistry, Biology/Mathematics and English, subject to verification of its equivalence with the 10+2 examination (Medical/Non-Medical Group) of the Punjab School Education Board by an appropriate authority. The NRI/OCI candidates educated and residing abroad seeking admission to various Masters'

programmes/MBA Agribusiness in PAU may be considered for admission without appearing in the entrance test of the University, provided they fulfil other prescribed qualifications.

4. The tuition fee (non-refundable) shall be payable by Bank Draft in US Dollars or any other currency acceptable by nationalised banks in India issued against the bank account in the account of NRI/OCI in the country in which he/she is residing or in the shape of bank draft in equivalent Indian currency issued against NRI/OCI account of the NRI/OCI maintained in India. In the latter case, the candidate is required to submit a certificate from the bank that the draft has been issued against the NRI account maintained by the NRI/OCI. The Bank Draft should be drawn in favour of the Comptroller, PAU, Ludhiana, payable at State Bank of India, PAU, Ludhiana or any scheduled Bank at Ludhiana, India. The hostel dues and other fee and funds as applicable will be charged in addition to admission fee as per University rules.
5. The candidates are required to produce a photo copy of citizenship certificate and passport duly attested by the Magistrate or Notary Public.

# ANNEXURE A-I

## Criteria for Admission of Outstanding Sportspersons

## UNDERGRADUATE PROGRAMMES

1. The order of preference for the selection of outstanding sportspersons for admission to various programmes of the constituent colleges of the Punjab Agricultural University shall be as per Annexure-B, subject to fulfillment of the prescribed minimum requirements for admission to a particular programme.
2. The candidate qualifying for grade 'O' shall be placed at higher merit than the candidate qualifying for grade 'A'. Similarly, the candidate qualifying for grade 'A' shall be placed at higher merit than the candidate qualifying for grade 'B' and so on.
3. The candidate qualifying for grade 'O' (1) shall be placed at higher merit than the candidate qualifying for grade 'O' (2) and so on.
4. The candidate who has won first position shall be placed at higher merit than the candidate who has won second position in a competition of the same level. Similarly, second position shall be placed at higher merit than the third position in a competition of the same level and so on.
5. If there is a tie between two or more candidates, then the tie shall be decided on the basis of merit in the entrance test or qualifying examination. If the tie still remains, then the candidate higher in age shall be admitted.
6. Only those sportspersons shall be eligible for admission against sports quota who have achieved minimum sports participation as per criteria laid down in the PAU Prospectus in last two academic years. If the Candidate is found eligible as per above condition, then his/her achievements for last three academic years will be considered.
7. Sports achievements of gap year after +2 or Matric will not be considered to get admission against sports quota.
8. In case of individual sports disciplines, position of the candidates in an individual event shall be considered and not the position of the team as a whole.
9. The candidate who has represented twice will be preferred over candidates who represented once in a competition of same level in a game and so on.
10. Only those candidates shall be admitted against sports quota who are eligible to participate in the University and Inter-Varsity Tournaments as per AIU rules. (Those students admitted against sports quota in 6 year programme cannot participate for the first two years of study programme in the North Zone/All-India Tournaments/competitions as per AIU Rules however, they can participate in any Open Distt./State/National Tournament.
11. The candidate shall be required to submit self-attested affidavit in the prescribed form as per Annexure-C regarding his/her achievements in sports. If the candidate is a minor, self-attested affidavit may be given by the parent/ guardian in respect of his/her ward's/child's achievements in sports.
12. The admission against the sports quota shall be finalized on the basis of recommendations of the College Sports Committee and approved by the Dean of the College concerned and the DSW/Deputy Director Sports/Joint Director Sports & Cultural Activities.
13. The Committee shall screen the applications and ascertain competence of the candidates through actual trials before interview. The coach of the concerned game may be co-opted as technical member, if necessary, for conducting the trials.
14. The admission of candidates against the sports quota shall be made on the explicit understanding that they shall attend the play fields regularly and shall also participate in the Inter-Class, Inter-College and Inter-Varsity Tournaments. If they fail to do so, their admission shall be can-celled.

15. The candidates admitted to B.Sc. (Hons) Agri., B.Tech. (Biotechnology), B.Tech. (Food Technology), B.Sc. (Hons) Nutrition and Dietetics, 5-year Integrated M.Sc. (Hons) programme in Basic Sciences, B.Sc. (Hons) Community Science, B.Tech. (Agril. Engg) programmes and other Bachelor degree programmes against the sports quota shall be enrolled in the NSO scheme of thethree fold programme. The participation in Inter-Class, Inter-College, Inter-Varsity, State and National Tournaments shall be governed by the existing rules as applicable to other academicand co-curricular activities.
16. Only those games/disciplines will be considered for admission in which Punjab Agricultural University participates in the Inter-Varsity/All-India Inter-Agrivarsity Tournaments and holds Inter-College Tournaments. The list of these games/disciplines is placed at Annexure-D.

# ANNEXURE A-II

## Criteria for Admission of Outstanding Sportspersons

## POSTGRADUATE PROGRAMMES

1. The order of preference for the selection of outstanding sportspersons for admission to various programmes of the constituent colleges of the Punjab Agricultural University shall be as per Annexure-B subject to fulfillment of the prescribed minimum requirements for admission to a particular programme.
2. The candidate qualifying for grade 'O' shall be placed at higher merit than the candidate qualifying for grade 'A'. Similarly, the candidate qualifying for grade 'A' shall be placed at higher merit than the candidate qualifying for grade 'B' and so on.
3. The candidate qualifying for grade 'O' (1) shall be placed at higher merit than the candidate qualifying for grade 'O' (2) and so on.
4. The candidate who has won first position shall be placed at higher merit than the candidate who has won second position in a competition of the same level. Similarly, second position shall be placed at higher merit than the third position in a competition of the same level and so on.
5. If there is a tie between two or more candidates, then the tie shall be decided on the basis of merit in the entrance test. If the tie still remains, then the candidate higher in age shall be admitted.
6. Only those sportspersons shall be eligible for admission against sports quota who have achieved sports achievement as per criteria laid down in the PAU Prospectus (Annexure B) during the undergraduate programme. Candidates should have participated at least twice in the University Inter-College Tournament and once in All-India Inter-Varsity/North-Zone Inter-Varsity Tournament/All-India Inter-Agricultural Universities at undergraduate level. Sports achievements of gap year after graduation will not be considered for admission against sports quota. Only those candidates shall be admitted against sports quota who are eligible to participate in the University and Inter-Varsity Tournaments as per AIU rules. Relaxation will be given for the games in which PAU Inter-College Tournament is not held and teams participating in the NZ/ AII-India Inter-Varsity on the basis of trials.
7. In case of individual sports disciplines, position of the candidates in an individual event shall be considered and not the position of the team as a whole.
8. The candidate who has represented twice will be preferred over candidates who represented once in a competition of same level in a game and so on.
9. The candidate shall be required to submit self-attested affidavit in the prescribed form as per Annexure-C regarding his/her achievements in sports.
10. The admission against the sports quota shall be finalized on the basis of recommendations of the College Sports Committee and approved by the Dean of the College concerned and the DSW/Deputy Director Sports/Joint Director Sports & Cultural Activities.
11. The Committee shall screen the applications and prepare merit list as per the achievements of the candidates graduating from the Punjab Agricultural University. However, candidates graduating from Universities other than PAU will have to appear in actual trials. Applicants will attach attested copies of certificates alongwith the application.
12. The admission of candidates against the sports quota shall be made on the explicit understanding that they shall attend the play fields regularly and shall also participate in the Inter-Class, Inter-College and Inter-Varsity Tournaments. If they fail to do so, their admission shall be can-celled.
13. Only those games/disciplines will be considered for admission in which Punjab Agricultural University participates in the Inter-University/All-India Inter-Agrivarsity Tournaments and holds Inter-College Tournaments. The list of these games/disciplines is placed at Annexure-D.

# ANNEXURE B

## Grading for Sportspersons

**Grade 'O'**

1. For winning any of the first three positions in the Olympic Games/World Games/World Cup Tournaments/ Commonwealth Games/Asian Games/World University Games.
2. For representing India in the above mentioned Games/Tournaments.
3. For representing India in formal Test Matches/Tournaments abroad/within the country.

**Grade 'A'**

1. For winning any of the first three positions in the Senior National Championship/Inter-State or Inter-Zonal Championship.
2. For representing All-India Combined Universities Teams for Seniors abroad/within the country.
3. For representing the National Teams for Juniors in the International Tournaments abroad/ within the country.
4. For winning any of the first three positions in the All-India Inter-University Tournaments representing PAU teams.
5. For winning any of the first three positions in the All-India Inter-University representing University teams other than PAU.
6. For winning any of the first three positions in the National Championship/Inter-State or Inter-Zonal National Championship for Juniors.
7. For representing the National Teams for Schools (U-19) in the International Tournaments with- in the country/abroad.
8. For representing the National Teams for Schools (U-17) in the International Tournaments with- in the country/abroad.
9. For representing the National Teams (U-16/Sub Junior*) in the International Tournaments within the country/ abroad.

**Grade 'B'**

1. For representing the State Teams in the Senior National Championships.
2. For winning any of the first three positions in Zonal Inter-Varsity / North Zone Championship organized by concerned game Association/ Federation recognized by IOA.
3. For winning first three positions in All-India Inter-Agricultural Universities Sports & Games Meet.
4. For winning any of the first three positions in the Zonal Inter-Varsity by representing Universities other than PAU.
5. For winning any of the first three positions in the National championships for Schools (U-19).
6. For representing the Union Territory teams in the Senior National Championships.
7. For representing the State Junior Team in National Championships.
8. For representing the Union Territory Junior Team in National Championships.
9. Participation in the All-India Inter-Varsity/ Zonal Inter-Varsity Championship/ North Zone Championship organized by concerned game Association/ Federation recognized by IOA.
10. For winning any of the first three positions in the Inter-District Championships for Seniors.
11. For winning any of the first three positions in the National championships for School (U-I7).
12. For winning any of the first three positions in the National championships (Sub-Junior*).
13. For representing the Punjab Agricultural University in the All-India Inter-Agricultural Universities Sports & Games Meet.

14. For representing University Teams other than the Punjab Agricultural University in All-India Inter-Varsity/ Zonal Inter-Varsity Championships.
15. For representing State Schools Teams in National School Games (U-19).
16. For representing the State Schools Teams (U-17) in National School Games.
17. For representing State Team in National (Sub Junior*) Championship.
18. For representing the District Team in the Interdistrict/State Tournaments for Seniors.
19. For winning any of the first three positions in State Junior Championships.
20. For winning any of the first three positions in State School Games (U-19).
21. For winning any of the first three positions in State School Games (U-17).
22. For winning any of the first three positions in State (U-16/Sub-Junior*) Championship.
23. For winning any of the first three positions in Indian Public School Council (I.P.S.C.)/Central Board of Secondary Education (CBSE) and Vidya Bharti School National Championship (V.B.S.)/ Kendriya Vidyalaya Sangathan (KVS)/ Navodya School/Indian Certificate of Secondary Educa- tion (ICSE) (U-19).
24. For winning any of first three positions in Indian Public School Council (I.P.S.C.)/Central Boardof Secondary Education (CBSE) and Vidya Bharti School National Championship (V.B.S.)/Kendriya Vidyalaya Sangathan (KVS)/ Navodya School/Indian Certificate of Secondary Education (ICSE) (U-17).
25. For representing District Junior Team in the Jr. State Championship.
26. For representing District School Team in Punjab State School Games (U-19).
27. For representing District School Team in Punjab State School Games (U-17).
28. For representing District Team in State games (U-16/Sub-junior*).
29. Participation in the Indian Public School Council IPSC/ICSE/CBSE/Vidya Bharti National Championship (U-17, U-19).
30. For winning any of first two positions in team games and first three positions in individual
31. events in Punjab Agricultural University Inter-College Tournaments
32. For winning any of the first two positions in the University Inter-College Tournaments otherthan the Punjab Agricultural University.

**Grade 'C'**

1. For winning any of the first three positions in the Union Territory Championships for Seniors.
2. For representing the University/College Team in Union Territory Championships for Seniors.
3. For winning any of the first three positions in Union Territory Junior Championships.
4. For winning any of the first three positions in District Championships for Seniors.
5. For winning any of the first three positions in District Championships for Juniors or School Games (U-19, U17).
6. For winning any of the first three positions in Union Territory School Games ((U-19, U-17).
7. * Minimum (U-16) age category will be treated as Sub-Junior.

## ANNEXURE C

## Self Declaration

I, .....son/daughter of Shri.....aged about..... ..... years, resident of ……..……..…….. passed Matriculation in the year……. and 10+2 in the year have achieved the following distinctions in the field of sports, I further state that in case any of the achievements stated below is found to be false, I shall be liableto be punished under the provisions of the law. I hereby give an undertaking that if I am admitted to…… programme at the Punjab Agricultural University in the category of sportspersons, I shall regularly attend the playgrounds and if I fail to do so my admission shall be cancelled by the Punjab Agricultural University.

| Sr. No. | Name of Sport/ Discipline | Name of Institution/District/ State represented | Venue and the Name of the Tournament with year & date | Position won | Category of Tournament (Senior/Junior) |
|---|---|---|---|---|---|
| | | | | | |

Verification

Deponent

I, the above named deponent, solemnly declare and affirm that the contents of my above declaration are true to the best of my knowledge and nothing has been concealed therein.

Deponent

## ANNEXURE D

## List of Games/Disciplines which will be considered for Admission IN THE PAU ON SPORTS BASIS

| | |
|---|---|
| • Athletics (Men and Women) | • Indoor Hockey 5's (Men and Women) |
| • Aquatic (Swimming, Diving & Water Polo) (Men and Women) | • Kabaddi (Men and Women) |
| • Badminton (Men and Women) | • Lawn Tennis (Men and Women) |
| • Basketball (Men and Women) | • Roller Skating (Men and Women) |
| • Cricket (Men and Women) | • Shooting (Men and Women) |
| • Cycling (Men and Women) | • Table Tennis (Men and Women) |
| • Football (Men and Women) | • Volleyball (Men and Women) |
| • Handball (Men and Women) | • Weight Lifting (Men and Women) |
| • Hockey (Men and Women) | |

SECTION III

# SEMESTER SYSTEM OF EDUCATION

**1. Medium of Instructions**

Instructions in all courses, both Theory and Practicals, are carried out in English language.

**2. Curricula Framing**

The most significant feature of education at the university is the progressive development of the curricula for various programmes. A curriculum is developed from the grassroots. The proposal on what is to be taught in a particular course is initiated by the teacher who may teach the course. This is discussed by the members of the faculty in the department concerned withrespect to the subject matter. The recommendations of the Department are then discussed inthe Board of Studies of the College concerned, where the relationship with other courses/ programmes and the time that ought to be given to a topic in the context of the total programme, are discussed. The proposals from the colleges are interlinked and cross checked in Resident Instructions Committee and then discussed in the Academic Council keeping in view the courses offered for different programmes. Thus emerges the University curricula duly approved bythe Academic Council of the University which normally come into force with immediate effect unless an adjustment period, not exceeding one academic year, is specified by the Council.

**3. Payment of Fees, Advisement, Registration and starting with the New Semester**

**Payment of Fees**

Both for the newly admitted students and the old students, demands of fees and other dues are raised by the College office. After the payment of the dues, a student is given cash receipt indicating that he/she has paid all the dues, including any pending bills of the hostels from the previous semester.

**Advisement**

An undergraduate student is advised and guided by an Advisor who is appointed when a student joins the University and he/she continues to advise the student throughout the course of his studies. At the undergraduate level he/she generally has a group of 10 students from the same batch to advise them in their day-to-day progress and the students are expected to meethim formally and informally at any time they find any difficulty relating to their academic programmes, financial position or even personal and family problems. The Advisor maintains a file of every student in which he/she keeps the registration cards, the semester reports (results) or any other information relating to student's sports and co-curricular activities, and also acts ofhis misbehaviour and indiscipline, if any. An Advisor can call the student or his guardian anytime in case he/she feels a student is not putting in his best in the studies and is not regular in attending the classes. Apart from the special advisement in the beginning of the semester,a period for advisement is provided in the weekly time table. All the students are supposedto meet their respective Advisor regularly during this period. They may also be arranged in tobigger group meetings which may be Department-wise, Class-wise or may be for the entire College. Due notices are given for all such formal meetings in which prominent speakers are invited to address the students and the faculty. In these meetings, the students are also invited to express their difficulties or give suggestions for improving the educational programme. This advisory system is the most essential feature of the semester system of education without which neither the students can comprehend the fast speed of imparting instructions in variousprogrammes nor the mistakes and lacunae in running the semester system can be corrected.

It is most vital that the students, the advisors, the teachers and the college administration, all work together with full understanding and perfect coordination.

The academic calendar is also announced well before the start of the new academic year in which every date for the various time-bound actions required by the students are mentioned. It is compulsory for a student to be personally present on the day of registration. The provision for late registration is only for exceptional circumstances and it is at the discretion of the Deanwhether or not to permit a student to register late because every day of delay means loss of lectures and Practicals which have to be made up by arranging extra classes.

On showing the cash receipt of having paid the dues, (the name and registration number are given on the receipt), the student can collect four blank registration cards of various colours meant for different offices indicated as under :

a. Registrar Yellow
b. Dean of the College Pink
c. Advisor Blue
d. Student Green

The student shall then meet the Advisor, who after consulting his file, his previous results and performance, will advise the student to take the appropriate teaching load which the student can handle. If a student has failed in a subject and that course is offered in that semester, he/she is advised to clear that course first as his overall credit point average (OCPA) would fall below the minimum required which is 5.50 out of a maximum of 10.00 (6.50 for postgraduate students). If his overall credit point average is below the minimum required, a student is automatically placed on Scholastic Probation which is indicated on his credit points sheet issued before the day of registration and which is available with the advisor of the student. The student is also advised to study the pre-requisite courses in time, otherwise he/she would not be allowed to study the higher courses in subsequent semesters. It is also very important for the student to clear the 100 series courses in the first year, all the 200 series courses in the second year and 300 and 400 series courses during the subsequent years.

The Advisor on seeing the overall credit point average also works out a strategy for the student as to how he/ she can improve his credit points so that he/she does not fall below the absolute minimum at which a student is automatically dropped from the University at the end of the first year and again at the end of the second year. It is provided in the Semester Rules that an undergraduate student, who obtains overall credit point average of less than 5.00 at the end of 2 semesters and 5.25 at the end of 4 semesters, is automatically dropped from the university. Similarly a postgraduate student who fails to achieve OCPA of 6.00 at the end of two semesters is automatically dropped from the university.

**Registration**

Having obtained general guidance as to the courses which a student should study in that semester, he/ she is asked to meet the respective teachers who are to offer the courses. The courses to be offered in the semester, their numbers, titles, credit hours for each, the name of the teacher and the Department are listed before the start of the semester and these lists are available with the advisors, who may also themselves be teachers for certain courses.

The student enters the particulars of the courses he/she is going to study in the semester and gets the signatures of the advisor and the teachers at the appropriate places on the cards. Having entered all the courses and obtained the signatures of all the teachers, the student brings the cards to the Accounts Officer who then signs at the appropriate place verifying that the dues have been paid, and the student is then directed to go to the Dean or his representative for checking all the entries for their correctness and he/she then puts the signatures on the cards. In large classes, the advisement and entry of courses on the cards are arranged in the Auditorium or a large lecture room where all the advisors and the teachers are present, which facilitates quick registration.

The student is then directed to go to the office of the Registrar or meet the representative of the Registrar in the Auditorium or the Lecture room where all students are gathered. After having checked the receipt for the payment of dues, all the entries of the courses and signatures of the teachers, Advisor, Accounts officer and the Dean, the Registrar or his representative, puts the signatures and affixes the stamp and the student is registered. The green card of the student is given to him and the remaining cards are retained by the Registrar for further checking and subsequent distribution to the respective offices, namely, the Dean and the Advisor. The student must retain his green card with him all the time because only on showing this card he/she will be allowed to sit in a given class. If there are more than one sections of a class, the student cannot, on his own, shift from one section to the other. He/she has to get permission from the teacher and the Dean before he/she is allowed to sit in that section.

For adding or withdrawing courses within the currency of the semester, the student should see Semester Rule No.4 ‘Change of Courses’ given in Section VI.

**4. Teaching of Courses and Internal/External evaluation**

Another important feature of the University is that within an overall framework of academic requirements, the teachers are encouraged to tailor the programme of work to the needs of individual students, who are evaluated by the teachers on the basis of their day-to-day performance. Education is imparted in the form of courses comprising lectures and Practicals in a semester, of about 21 weeks each, spread over several semesters. In an academic year, there are two semesters. In each semester, depending upon his/her individual capacity a student may take 4 to 6 courses of 12 to 24 credit hours in undergraduate programmes and 9 to 18 credit hours in postgraduate programmes (for MBA programme maximum limits is 21 credit hours). One credit hour involves one lecture per week or two contact hours of practicals. The 6 courses for an average student may amount to 19-20 credit hours. A less capable student may take one or two courses less than this but not below 12 credit hours in order to be able to devote more attention to fewer courses. A more intelligent student may take one or two additional courses but not more than 24 credit hours and thereby qualify himself for the degree at an earlier date. During the course of 21 weeks there will be at least three examinations and some assignments in each course. Each of the tests and assignments count towards the final grade a student will earn. Each of the answer paper of all the tests, examinations and assignments except that of end-of-semester examination is returned to the student and the student is free to discuss his answer/evaluation with the teacher. After the end-of-semester examination, the student may see the answer book of the final examination within 15 days of the start of the following semester. Thus the student remains aware of his status in the class and teacher remains in the know of the performance of the student. The answer books of the end-of-semester examination are kept by the concerned teacher for full one semester following that in which the examination is conducted. After that the teacher disposes of all the answer books.

With a view to improve the existing system of internal evaluation of Postgraduate programmes, the Academic Council has laid down the following guidelines:

i) Where courses are offered to more than one section, a common question paper may be set up in order to ensure uniformity in the standards of assessment.

ii) The question papers may be invited in the beginning of the semester in order to ensure that contents in a particular course are covered to the desired level.

iii) The course outlines of individual courses should be prepared and given to students in the beginning of the semester in which it is offered.

Apart from these general guidelines, the University has also prescribed the following guidelines regarding internal evaluation by the close relatives of the students:

i) As far as possible a teacher, who has a son or a daughter studying in a particular class, should on his own refrain from teaching that course and making assessments for the credit points. Some other faculty members may be asked to teach that course in that semester.

ii) If the course is so highly specialized, particularly at the postgraduate level, that no other teacher is available for teaching, an exception may be made by the Dean concerned on the recommendation of the Head of the Department. In that case the head of Department will himself supervise the assessment for the award of credit points.

The Academic Council has introduced the external evaluation system of the end of semester examination for all the undergraduate programmes from the academic session 2005-06. The external evaluation system is restricted to the final Theory examination of only credit courses, while the Practical is conducted internally. The weightage of final examination of each course should not be less than 35% of the total marks.

A salient feature of the resident instruction at the university is its integration with research and extension. The purpose of training a student is to acquaint him with real agricultural and rural problems. A sound training in basic and applied sciences is imparted first and in the later years, the student is taught to apply this knowledge to the solution of day-to-day problems. This can be possible only if those who impart the instructions are themselves actively involved in the solving of these problems. Similarly, researchers also shoulder teaching responsibilities in their field of specialization to expose the students to their rich Practical research experience.

All required courses shall normally be offered in the semester indicated, unless the Dean of the College (for undergraduate courses) and the Dean, Postgraduate Studies (for postgraduate courses) for special reasons to be recorded, gives the permission not to offer those courses in the semester shown. Similarly the courses to

be offered in alternative years, may also be offered compulsorily unless the Dean concerned gives permission to change the semester in which they should be offered.

If a course, after having been listed in the Resident Instruction Bulletin, is not offered in four consecutive years for one reason or the other, it would be considered to have been deleted, unless it is revised and modified and is approved by the Academic Council.

Ordinarily, no course shall be offered to a single student.

**5. Examinations**

When the teacher meets the class, he/she gives an outline of the course work on the very first day. The teachers are expected to give references to the chapters of various books and the other reading material, relevant to the various lectures. The teacher also announces in the class, the approximate date when he/she would be giving the first-hourly test. He/she might decide that instead of the first-hourly test, he/she will give the second-hourly test which will be after the mid-term examination. The dates for the mid-term examinations are fixed and are given in the Academic Calendar. All the teachers are required to adjust their examinations within those dates and are advised not to prolong the period of examinations so that it does not interfere with the actual imparting of the instructions. The final examinations of the Practicals are held in the 20th week of the semester in the regular period meant for the Practicals. The date-sheet for the final examination in Theory are announced by the Registrar and strict schedule has to be maintained in order to avoid clashes or two examinations on a given date.

In the semester system of education, the evaluation for postgraduate programmes is internal by teachers themselves. The Heads of Departments are empowered to ask the teachers to set the final examination paper in the beginning of the semester and keep it in his own safe custody. If the head of the Department so feels, he/ she might also ask teachers of various sections of the class to exchange answer books of examinations among themselves and mark the papers. The evaluation of the end of semester examination of credit courses for undergraduate programmes is external. The Practical is conducted internally and the weightage of each course is normally 35 % marks allocated to Theory portion The credit points sheet are prepared on the basis of cumulative marks of all the tests obtained by a student in a given course. In the master-sheet, marks for each test are recorded which are kept in the office of the Dean. Before the Head of the Department forwards the results to the Dean, he/she is expected to thoroughly scrutinize the credit points and also to check some of the answer-sheet at random in order to satisfy himself that the marking has been fair. The percentage of marks obtained in each course are converted to credit points, as follows:

| Per cent of marks obtained in a particular course | Corresponding credit point |
|---|---|
| 100.0 | 10.00 |
| 99.0 | 9.90 |
| 98.0 | 9.80 |
| 97.0 | 9.70 |
| 96.0 | 9.60 |
| 95.0 | 9.50 |
| and so on | |

Dean, after signing the credit points sheets, sends them to the Registrar who compiles the credit points sheets within the period of inter-semester break. It is essential in this system of education that the credit points sheets are ready before the next registration. The Registrar prepares five copies of the semester reports, which indicate not only the result of the courses studied by the student in that semester, but also the accumulated overall credit point average, showing the scholastic standing of the student. One copy of the semester report is

sent to the parents/guardians of the student at their permanent home address, one copy is meant for the Dean for maintaining the file of the student, one is sent to the Advisor of the student and one is for the student himself.

The student who falls below the minimum required OCPA of 5.50 (for an undergraduate programme) and 6.50 (for a postgraduate programme) out of 10.00 is placed on Scholastic probation and is dropped, with the option to make an appeal to the Dean concerned within 5 days. The Dean, in the presence of the student, the Advisor and other senior faculty, decides whether a student may be given another chance to improve his/ her OCPA or that he/ she may be dropped from the University. After the final decision is taken by the Petition Committee, the Registrar is asked to convey it to the concerned students. If it is decided to give a chance to the students to improve their overall credit point average, they are allowed to register for the next semester and are placed on Scholastic Probation.

**Formula for inter-conversion of the OGPA/OCPA and aggregate percentage of marks under the traditional system of examination**

The following formulae have been adopted by the University to determine the equivalence of each grade point average (from 1 to 4) and overall credit point average (from 1 to 10) under the semester system in terms of the percentage of marks awarded under the traditional system of examination:

1. For conversion of Overall Credit Point Average (OCPA) into percentage of marks: $Y = 10Z$

   Where Y = Percentage of marks in the traditional system Z = Overall Credit Point Average (OCPA) in 10.0

**Point system of evaluation**

2. For conversion of Overall Grade Point Average (OGPA) into OCPA

a) For undergraduate programmes

$Z = (50 - 10X + 5X^2)/10$

Where Z = OCPA in 10.00 point system of evaluation

X = OGPA (maximum=4.00) in the letter grade system of evaluation

b) For Postgraduate Programmes

$Z = (25 X -15)/10$

Where Z = OCPA in 10.00 point system of evaluation

X = OGPA (maximum = 4.00) in the letter grade system of evaluation

**Note:-** OCPA is out of 10.00 and OGPA is out of 4.00 where ever mentioned in the Prospectus, unless otherwise specified.

SECTION IV

# POSTGRADUATE INSTRUCTIONS

## 1. Resident Instructions

The main objective of the postgraduate programmes at the Punjab Agricultural University is to develop leadership in science for the development of agriculture in the State. Therefore, these leaders-to-be must understand the problems of the region and should be trained well in the known scientific fields. The second objective is to develop scientific human resource sufficiently trained with higher education, who can become specialists in various science disciplines in agriculture, basic sciences, agricultural engineering & technology and home science. As the problems of agriculture are complex, these specialists must be trained not only in very specialized fields of science but they must also have the requisite broad-based knowledge of the related fields. With this wide perspective, such agricultural specialists would not only understand the problems of the farmers more realistically but also would be in a better position to solve their problems by various effective approaches.

The University offers postgraduate degrees at Master's level in 46 and at Doctorate's level in 30 disciplines. At the Master's level, the students are required to complete at least 70 credit hours (40 course work and 30 research) in addition to the credit hours for the deficiency courses, if any. At the Ph.D. level at least 75 credit hours (25 course work and 75 research) are required to be completed. In addition to successful completion of the course work, a student is required to conduct original research for M.Sc./M.Tech. and Ph.D. programmes and project work for MBA, MBA(AB), MJMC and MCA, based on a synopsis of research/ concept note of project problem prepared by the student under the guidance and supervision of the major advisor and the advisory committee. The research/project problem is related to the field of specialization of the major advisor. The postgraduate students are, thus, trained according to the needs of the State for the required scientific manpower.

## 2. The Dean of the Postgraduate Studies

The Dean of the Postgraduate Studies is the chief administrative officer for postgraduate studies and is directly responsible to the Vice Chancellor for the administration of all resident teaching programmes at the postgraduate level in the University, and for the development, evaluation and improvement of curricula and teaching procedures designed to develop professional competence, character and quality of leadership in students.

The Dean of Postgraduate Studies has the following powers and duties:

i. He shall be responsible for the organization and conduct of postgraduate teaching in all the constituent colleges of the University and for that purpose, shall pass such orders as may be necessary in consultation with the Deans of the constituent colleges and the Directors of Research and Extension Education, where such consultation is considered necessary.

ii. He shall, in collaboration with the Director of Research, be responsible for the coordination of research of the postgraduate students and its integration with the general research programmes of the University.

iii. He shall preside over the meetings of the Postgraduate Committee.

iv. He shall formulate and present policies to the Postgraduate Committee for its consideration, without prejudice to the right of any member to present any matter to the Postgraduate Committee.

v. He shall forward the recommendations of the Postgraduate Committee, to the Vice Chancellor or the Academic Council as the case may be.

vi. He shall maintain record of the postgraduate students in the Punjab Agricultural University and also supervise their progress.

vii. He shall be responsible for maintenance of proper standards of postgraduate instructions.

viii. He shall, in consultation with the Heads of Departments, exercise control over the teaching load of the members of the Postgraduate Faculty.

ix. He shall provide, in consultation with the Heads of Departments, guidance and leadership in the development of periodic evaluation of effective curricula within each subject-matter and integration of said curricula into

appropriate instruction programme designed to prepare students for effective careers in research, teaching and extension.

x. He shall be a member of the Academic, Research and Extension Council of the University.

xi. He shall be the Chairperson of Resident Instruction Committee.

xii. He shall perform such other duties as may be entrusted to him by the Vice Chancellor from time to time for effective coordination of postgraduate teaching in the University.

**3. Postgraduate Faculty**

The Postgraduate Faculty consists of the Deans, Directors, Professors, Associate Professors and such other teachers who are nominated by the Postgraduate Committee on the recommendation of the Heads of Departments concerned and the Dean, Postgraduate Studies and approved by the Academic Council. All other members of the faculty, who have a Ph.D. degree in their field of specialization, are also the members of the Postgraduate Faculty. The Postgraduate Faculty shall meet at least once in each semester in their respective departments.

**4. Student's Advisory Committee and Guidance**

The Head of Department himself, or the Chairperson of the departmental academic committee (Teaching) on his behalf, shall guide all the newly admitted students in selecting the courses of study during the first semester till major advisors are assigned.

A major advisor will be assigned to each postgraduate student in the first semester by the Head of the Department concerned, and approved by the Dean, Postgraduate Studies. Besides, there will also be an advisory committee for each student which will be constituted on the recommendations of the major advisor and the Head of the Department as per semester rule 5.2 and approved by Dean, Postgraduate Studies.

The major advisor shall not have more than ten postgraduate students at any time and shall not be assigned more than three students in one academic year.

The major advisor/member of the advisory committee/nominee of the Dean, Postgraduate Studies of a postgraduate student proceeding on foreign assignment or long leave/maternity leave for a period of more than six months should request the Head of the Department at least one month before proceeding on such leave/ foreign assignment etc. for appointing a new major advisor/committee member/ nominee of Dean, Postgraduate Studies. These changes in the advisory committee shall become effective only after these have been duly approved by the Dean, Postgraduate Studies.

The Advisory Committee shall guide a student in the choice of courses for preparing programme of study, selection of a suitable research problem for thesis/dissertation and in all other matters relating to the student's academic activities.

**Guidelines for allotment of Major Advisors to Postgraduate Students**

The list of the faculty members who are to be allotted PG students during a particular semester/ year shall be prepared according to their eligibility and seniority, alongwith their fields of specializations. A teacher must fill only one specialization. The list will be displayed at the notice board of the department and also be available with the office where the same can be seen by the students.

After admission of the students in postgraduate programmes, the Head of the Department along- with the Chairman Academic Committee (Teaching) shall call a meeting of the newly admitted PG students within three weeks of the start of the Semester. In this meeting, the students will be oriented regarding fields of specializations existing in the department and about the semester system. The fields of specialization given in the Resident Instruction Bulletin may be reviewed by the concerned department and proposal for any change may be forwarded to the Dean, Postgraduate Studies.

All the teachers in the respective disciplines employed in or outside the department, will be allotted the postgraduate students at par keeping in view his/her seniority irrespective of the fact whether the teacher is employed in teaching, research and extension scheme. In case of inservice candidates, the allotment shall be made in the area of specialization of the PG student.

Following guidelines (approved by the Vice Chancellor) are followed for allocation of major advisors to postgraduate students:

**For M.Sc. students**

i. Specialization within the subject not to be considered for allocating major advisor to M.Sc. students.

ii. List of eligible teachers equal to the number of admitted students in that year to be displayed on the notice board. Eligibility of teachers will be turn-wise starting from where the allotment ended in the previous year; this process to continue till the list of all eligible teachers is exhausted.

iii. All students to be asked to give preference for major advisor for all the listed eligible teachers in descending order.

iv. Among the listed eligible teachers, major advisors to be allotted as per rank of the admitted students in the entrance examination. For example, the student with highest rank will be the first one to get his/her major advisor as per his/her choice and the second ranked student will be allotted major advisor from the remaining eligible teachers as per his/her choice. This procedure will continue as such till all the students are allotted major advisors.

**For Ph.D. students**

i. Specialization within the subject to be mentioned for allotment of major advisor to Ph.D. students.

ii. List of eligible teachers along with their area of specialization equal to the number of admitted students in that year to be displayed on the notice board. Eligibility of teachers will be turn- wise starting from where the allotment ended in the previous year; this process to continue till the list of all eligible teachers is exhausted.

iii. All students to be asked to give preference for major advisor for all the listed eligible teachers in descending order.

Among the listed eligible teachers, major advisors to be allotted as per rank of the admitted students in the entrance examination. For example, the student with highest rank will be the first one to get his/her major advisor as per his/her choice and the second ranked student will be allotted major advisor from the remaining eligible teachers as per his/her choice. This procedure will continue as such till all the students are allotted major advisors.

**Criteria for preparation of merit list of PG and Ph.D. students for allotment of major advisors:**

| Category I | Category II | Category III |
|---|---|---|
| (All except foreign and inservice Ph.D. students)<br>Those getting SRF on the basis of their merit in SRF examination.<br>Others on the basis of merit in PET<br>Those who qualify ALL India Competitive Examination (AICE-SRF-PGS) conducted by ICAR, and admitted against 25% seats as per admission procedure of the University. | (Inservice Ph.D. students)<br>1. As decided earlier conveyed vide this office U.O. No. 2701-40 dated 25.2.2015 and as per suitability for developing competent human resource. | (Foreign Students)<br>1. As per the requirements of foreign students. |

Those teachers who have two years to retire can guide Master's and three years to retire can guide Ph.D. students. Major advisor may be allowed to continue as major advisor even after superannuation, provided rough draft of the dissertation has already been submitted, else the student shall be re-allocated to any other appropriate teacher as major advisor. However, in case of the Ph.D. students, Co-Major Advisor should be kept on the advisory committee of the student. However, if such an allotment is made, the teacher will cease to be the major advisor on his/her superannuation. The certificate-I in the thesis will accordingly be modified as under:

This is to certify that the thesis/dissertation entitled " ....." submitted for the degree of M.Sc./M.Tech./Ph.D., in the subject of ..... (Minor subject: ) of the Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by under the supervision of ..... ..... upto. and under my supervision thereafter for the completion of degree, and that no part of this thesis/ dissertation/project report has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

**Major Advisor**

(This certificate will also be applicable to the cases where substitution of the major advisor has been approved by the Dean, Postgraduate Studies)

**4.1 Guidelines for teaching postgraduate courses**

i. To teach a 500-series course, a teacher must belong to the Postgraduate Faculty, and must have at least Master's degree in the concerned discipline.

ii. To teach a 600-series course, a teacher must belong to the Postgraduate Faculty and must have a Ph.D. degree in the concerned discipline.

iii. The teachers (including those on research and extension side) posted in the department other than their parent department, may be given teaching assignments of the postgraduate students from the Department (the discipline to which they belong).

**4.2 Guidelines for guiding research of postgraduate students**

4.2.1 For becoming major advisors of Master's students Associate Professors and above and their equivalents or Assistant Professor and equivalent with Ph.D. degree in the discipline/subject who has published two research papers other than his/her own Master's and Ph.D. theses (relaxable to Master's degree in the faculties of Community Science and Engineering, subject to the approval of the Academic Council).

4.2.2 For becoming major advisors of Ph.D. students

i. Ph.D. in the discipline.

ii. A teacher must have guided or is guiding two Master's students and has published four re- search papers having a NAAS rating of 4 and above or 4 research papers in Agricultural Re- search Journal, PAU (other than his/her own Master's and Ph.D. theses)

or

A teacher must have guided at least one Master's student and has published at least four re- search papers having NAAS rating of more than 6 or 4 research papers in Agricultural Research Journal (Journal of Research, PAU – OLD) or the combination thereof or Must have guided successfully as Major Advisor, atleast three M.Sc. students.

**Note I:** The employees of the outside institutions, such as ICAR, Central Government, Punjab State Government, etc. who are stationed at Ludhiana may be allowed to act as major advisors of the students if they fulfill the requirements and are approved by the Academic Council on the recommendation of Postgraduate Committee. This will also include National Fellows, Professors of Eminence, etc. In such cases, the ICAR employees will be treated as members of the faculty of the concerned discipline for teaching of courses and allotment of postgraduate students according to the University rules.

**Note II:** For making PG students allotments to the teachers, a joint seniority list of all the teachers of a faculty/ discipline posted at Ludhiana, shall be prepared by including the names of teachers working in the parent department and those posted in the departments other than their parent department. The allotment of PG students to the advisors shall be done from this joint seniority list. The eligibility of a teacher for becoming PG students advisor shall, of course be as per clauses 4.2.1 and 4.2.2.

The choice of the students for working at research stations shall also be taken especially if the conditions for conducting research on a particular crop/under particular conditions or situations so warrant. The students who want to do their research work at research stations should be allotted Major Advisors from the eligible faculty posted at the research stations and Co-Major Advisors from the faculty posted at Ludhiana.

Whenever a major advisor is appointed from an out station of the University, there shall be a Co-Major Advisor at the PAU main campus, and in the absence of Co-Major Advisor, the concerned Head ofthe Department shall act as Co-Major Advisor.

The students who have to conduct their research, one part at Ludhiana and the other at research station, shall be allotted Major Advisor from the faculty at Ludhiana and a Co-Major Advisor at the research station at which a part of research experiment has to be conducted.

**4.3. Duties of a Major Advisor**

i. The major advisor shall guide the student for all aspects.

ii. The major advisor shall meet his students very frequently and keep in touch with their progress during informal meetings which can be in office or laboratory/field where the student is working. The major advisor is supposed to maintain the attendance record of the student(s).

iii. The major advisor shall not sign registration cards before the day of registration so that the students do not get themselves registered by proxy.

iv. The major advisor while signing the cards shall ensure that the courses, for which a student is registered, are actually included in the programme of work duly approved in the Resident Instruction Bulletin and are offered during that semester.

v. The major advisor shall ensure that a student registers for 2 research credit hours for Masters and 3 for Doctorate for preparing synopsis and he/she should not register for any more research credit hours until the submission of the synopsis.

vi. The major advisor shall ensure that requests for excess and less credit hours be sent well in advance before the start of the new semester.

vii. The major advisor must ensure that synopsis of research and thesis/dissertation is written as per guidelines issued for these purposes.

viii. The major advisor shall note that the title of the thesis/dissertation when submitted should be the same as of the synopsis approved earlier. If any changes are required to be made, this should be done with the permission of Dean, Postgraduate Studies, well before the submission of rough draft of the thesis/ dissertation.

ix. The major advisor shall recommend all the cases by quoting rules and instructions issued by the Academic Council from time to time.

x. All the members of the advisory committee must be present on the day of comprehensive (oral) and final viva-voce examinations.

xi. It is the duty of the major advisor to guide the students regarding their day-to-day academic activities to complete the degree well in time.

**5. Requirements for completion of Postgraduate Degrees**

The advisory committee shall guide a postgraduate student in the choice of courses in the major, supporting and minor fields, and assign additional courses which a student as may be required to study to meet any deficiencies that he/she may have had in his/her previous programmes. The programme of courses to be taken shall be drawn by the advisory committee of the student by the end of the first semester of the programme and five copies of the same shall be submitted for approval to the Dean, Postgraduate Studies. After approval, three copies shall be returned, one each for the Head of the Department, major advisor and student. The fourth copy shall be sent to the Registrar.

The major, supporting and minor courses shall be according to the minimum requirements for the particular programme to which a student is admitted. The courses required to be taken by the student in order to meet certain deficiencies shall be over and above the minimum requirements and these are called deficiency courses and are to be entered in the programme of study in the appropriate columns. These deficiency courses shall have to be completed by the student before he/she is entitled for the award of the degree and in each of these courses, he/she has to obtain 'S' grade.

**5.1 Requirements for M.Sc./M.Tech. degree**

The minimum credit hours required for Masters' Degree for the disciplines shall be:

| | | |
|---|---|---|
| i) | Major courses | 20 |
| ii) | Seminar (From the major field only) | 01 |
| iii) | Supporting courses | 06 |

| | | |
|---|---|---|
| iv) | Minor courses | 08 |
| v) | Common Courses | 05 |
| vi) | Master's research | 30 |
| Total | | 70 |

**5.2. Requirements for Ph.D. degree**

The minimum credit hours required for Ph.D. programme for all the disciplines shall be :

| | |
|---|---|
| i) Major courses | 12 |
| ii) Seminars (Seminar I and Seminar II)<br>(At least one of the two seminars shall be from the major field and the other may be from minor or supporting fields) | 02 |
| iii) Supporting courses | 05 |
| iv) Minor field courses | 06 |
| v) Ph.D. research | 75 |
| Total | 100 |

**Note:**

1. **Major courses: From the Discipline in which a student takes admission.**
2. **Minor courses:** From the subjects closely related to a student's major subject
3. **Supporting courses**: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence.
4. **Common Courses**: The following courses (one credit each) will be offered to all students under- going Master's degree programme.

| Sr. No. | Course title | Course Title | Credit Hours | College/ Department Offering these courses |
|---|---|---|---|---|
| 1 | PGS-501 | Library and Information Services | 0+1 | Library |
| 2 | PGS-502 | Technical Writing and Communications Skills | 0+1 | COBSH, (Deptt. Of Agricultural Journalism, Languages & Culture) |
| 3 | PGS-503 | Intellectual Property and its management in Agriculture | 1+0 | College of Agriculture (Deptt. of Plant Breeding & Genetics) |
| 4 | PGS-504 | Basic Concepts in Laboratory Techniques | 0+1 | COBSH, (Deptt. of Chemistry in association with Deptt. of Botany, School of Agricultural Biotechnology and Deptt. of Electrical Engineering & Information Technology) |
| 5 | PGS-505 | Agricultural Research, Research Ethics and Rural Development Programmes | 1+0 | College of Agriculture (Deptt. of Plant Breeding & Genetics) |

Some of these courses are already in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the HoD/BoS.

4. Stat. 502 shall be compulsory supporting course for all master's programmes and deficiency course for Ph.D. programmes. If a master's degree student takes Statistics as a minor field, Stat. 502 shall be included as minor.
5. No course from the field listed as major or minor can be taken as supporting course. This shall apply to all the departments except those in which separate sub-disciplines have been approved.
6. For Master's degree programmes, major field courses shall normally be of 500 series having numbers 501 and above.
7. At least 6 credit hours of the minor courses shall be from minor field only.
8. For Ph.D. programme, the major field courses shall normally be of 600 series whereas 500 series courses may be listed under minor/supporting fields provided these are from departments other than the major field. All the courses that have numbers lower than 500, shall be listed as deficiency courses.
9. RPE-601 (Research and Publication Ethics, 1+1) shall be optional supporting course for Ph.D. programmes across all the disciplines, except for the disciplines of Agronomy and Agricultural Economics for which it shall be offered as compulsory supporting course.
10. Compulsory deficiency courses for Ph.D. programme if not studied these or equivalent courses at Master degree level are French 501, PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 and Stat 502.
11. Total credit load (including deficiency courses but excluding research credits) of International students on the rolls of the University has been restricted to 50 and 40 for Masters' and Ph.D. programmes, respectively.

    The programme of study once drawn shall be followed strictly by the student. Only under exceptional circumstances the programme of study may be altered by the advisory committee during the course of studies of the student to meet the changed scholastic circumstances as per the provisions of Semester and Hostel Rule 7.6. The programme shall not be altered to suit the convenience of the student or to facilitate his/her getting out of those courses in the programme which he/she finds difficult.

**5.3 Withdrawal/addition of courses from Programme of Work**

All the courses under major, supporting and minor fields shall be suggested by the advisory committee according to a student's requirements in a certain area which are listed in the RIB and according to the needs of his/ her proposed specialization, particularly the research problem he/she plans to undertake subsequently.

Any subsequent change in the Programme of Work by adding some courses and deleting others, recommended by the advisory committee, shall be submitted to the Dean, Postgraduate Studies, for approval. Such changes shall be notified to the Registrar. All students shall note that adding or dropping a course during the currency of a semester may be made only if this course is included in the Programme of Work. Any change in the Programme of Work itself shall be got approved from the Dean, Postgraduate Studies before the start of the semester. However the course in which the student obtained 'F' / `US' grade, will not be deleted.

**5.4 Exemption from courses**

Exemption from courses based on equivalence shall be recommended by a Department level committee consisting of the following:

| | | |
|---|---|---|
| i. | Head of the Department | Chairman |
| ii. | Major Advisor | Member |
| iii. | Chairman, Academic Committee (Teaching) | Member of the Department |
| iv. | A subject specialist | Member |

While considering the cases of exemption from courses, the requirement of credit hour and 80 per cent equivalence has to be given weightage in order to ensure quality of education. In case of any dispute, the matter shall be referred to the Dean, Postgraduate Studies. The recommendation shall become effective after these have been duly approved by the Dean, Postgraduate Studies.

**5.5 Submission of Synopsis of Research**

A postgraduate student shall submit to the Dean, Postgraduate Studies, through major advisor and Head of the Department, the synopsis of his/her research problem before the start of their second semester of his/her studies. The subject of the thesis shall, as far as possible, relate to the research needs of the State and the area of specialization of the major advisor and shall be approved by a committee consisting of the following under the Chairmanship of the Dean, Postgraduate Studies:

i) Student's Advisory Committee

ii) Head of the Department concerned

iii) Dean of the College concerned

iv) Director of Extension Education

v) Director of Research

vi) Dean, Postgraduate Studies

The Dean, Postgraduate Studies, shall communicate the approval of the synopsis to the Head of the Department/major advisor concerned along with a copy of the approved synopsis. Normally, the work on the research problem shall not be undertaken before its approval. The progress of research work shall be reviewed by the advisory committee during each semester and communicated to the Dean, Postgraduate Studies.

In all the Masters' programmes in the University where only Project Report is required to be submitted in partial fulfillment of the requirements of the degree, instead of the synopsis, a concept note with respect to each student highlighting his/her research programme will be prepared at department level under intimation to Dean, PGS. Research proposal as per prescribed format will be submitted to Head of Department.

However, such a proposal in case of Business Management will be submitted by 30th September in 3rd semester by MBA and MBA(AB) students. Late submission of research proposal will be allowed upto 31st Oct. with a fine of Rs. 2000/-. Beyond that a fine of Rs. 5000/- will be charged.

**5.6 Preliminary Examination for Ph.D.**

There shall be a preliminary examination for Ph.D. students to be held on successful completion of atleast 75 per cent of the course work. The preliminary examination shall include a writ-ten examination followed by an oral test. The written examination shall consist of two papers, one in the major field and the other in the minor field. The Major Advisor shall be responsible for conducting the written examination in the major field in consultation with the teachers who have offered various courses related therewith. The written examination in the minor field shall be conducted by the advisory committee member representing the minor field. The question papers shall be so designed that these test overall comprehension of the student in the major/minor field and are not restricted only to the courses studied. The process of written examination of both major and minor fields shall be completed within a month after the start of first examination and the result communicated to the Dean, Postgraduate Studies within 10 days thereafter.

The oral examination shall be conducted by the Student's Advisory Committee with an additional member from outside the University who shall be chosen by the Dean, Postgraduate Studies from a list of names submitted alongwith the result of the written examination to him by the Head of the Department in the major field, provided that the Dean, Postgraduate Studies may appoint any person even outside the panel recommended by the Head of the Department.

If a student fails in the preliminary examination, he/she shall be allowed to re-appear in the examination not earlier than three months after the first examination.

**6. Submission of Thesis/Dissertation and Final Examination**

A postgraduate student shall write thesis/dissertation as per the prescribed guidelines already circulated by the o/o Dean, Postgraduate Studies and also available on the University website (www.pau.edu ). Before the student is allowed to submit the rough draft of his/her thesis, he/she should present the results of his/her research and discuss these in a seminar where members of the advisory committee, other faculty members and postgraduate students are present. Notice for the seminar should be given atleast a week in advance, to ensure full participation of faculty and PG students. The suggestions and constructive criticism of the faculty should be made use of by the student for further improving the draft of the thesis/dissertation.

The rough draft of the thesis/dissertation shall be submitted to the members of the advisory committee for their comments before the final submission of the thesis/dissertation to the Dean, Postgraduate Studies through the Head of the Department. Thesis/Dissertation can besubmitted on any date during the semester. The actual procedure for the submission of the thesis/dissertation is as under:

A postgraduate student shall submit his/her rough draft of the thesis (M.Sc.)/dissertation (Ph.D.) after he/she has successfully completed his/her course requirements and the requirednumber of research credits, to the members of the advisory committee and one copy to Dean, Postgraduate Studies. The Major Advisor/Advisory Committee and Head of the Department must ensure that thesis/dissertation is written as per the guidelines issued by the Dean, Post-graduate Studies. The members of the advisory committee shall return the rough draft of thesis/ dissertation within 10 days of its receipt along with their suggestions for corrections or improvements. After the suggestions are incorporated in the thesis/dissertation to the satisfaction of the major advisor and the advisory committee, Certificate I and II shall be incorporated therein after the title page. One copy of the thesis/dissertation shall be submitted to theDean, Postgraduate Studies. A panel of five proposed External Examiners is to be sent to the Dean, Postgraduate Studies by the Head of the Department alongwith the signatures of the major advisor as per instructions issued by the Dean, Postgraduate Studies. The external examiner, who shall be a specialist in the student's major field of study, shall be appointed by theDean, Postgraduate Studies, who will have the power to appoint any person even outside thispanel. The panel duly approved by the Dean, Postgraduate Studies will be sent to the Registrar.The process of appointment of the external examiner, obtaining their consent and the possibledate of conducting the final viva voce examination are settled through correspondence.

The student will submit the final thesis/dissertation/project report at least 10 days after the submission of rough draft of thesis/ dissertation and maximum 3 months for Masters programme and 6 months for Ph.D. programme accompanied with a receipt for having paid the prescribed thesis fees, through the Head of the Department concerned. The thesis/dissertation/project report shall be sent to the external examiner by post by the Registrar. In the caseof Ph.D. students there will be two external examiners for the evaluation of Ph.D. dissertation, out of two one external examiner as recommended by Dean PGS shall conduct viva-voce. Ph.D. students shall submit two copies of final dissertation for the external examiners. The external examiner shall send the evaluation report of the thesis/dissertation to the Registrar. The Registrar shall fix a date for the examination for the student only after obtaining the evaluation report. If the external examiner recommends the acceptance of the thesis/dissertation for PG programme, then the oral examination is arranged, which is held by the external examiner, members of the advisory committee, the nominee of the Dean, Postgraduate Studies, and such other members of the postgraduate faculty and additional person(s) from outside the University, as may be nominated by the Dean, Postgraduate Studies. The final oral examination shall normally be conducted after at least 10 days of sending the thesis/dissertation to the external examiner. However, the Dean, Postgraduate Studies may relax this condition of 10 dayslimit to conduct the oral examination only in the case of exigency. Each postgraduate student will submit four hard copies and two soft copies of thesis/dissertation/project report. The student will submit the abstract of thesis/dissertation/project report both in English and Punjabi.

The Dean, Postgraduate Studies shall make arrangements, through the Registrar, for the conduct of oral examination of a student of PG programme by his/her advisory committee alongwith an External Examiner. If the external examiner rejects the thesis/dissertation, this may be placed before the advisory committee for a decision. If the advisory committee accepts the recommendations, then the thesis/ dissertation is rejected. If the advisory committee does not agree with the verdict of the external examiner, then the thesis/dissertation shall be re-examined by another external examiner whose decision for conducting the oral examination willbe final. If the thesis/dissertation is not accepted, the candidate may be allowed to re-submitthe revised thesis/dissertation after a lapse of not less than one semester to be considered inthe same manner as the original submission. A student who either fails to appear or fails in the final oral examination, should apply for arranging a fresh examination through the Head of theDepartment. If the circumstances are beyond the control of the student, the Dean, Postgraduate Studies may permit the re-examination within the same semester; if however, the Dean, Postgraduate Studies is not satisfied with the circumstances stated by the student, the studentshall register for one more semester and the examination shall be arranged on the payment of fresh thesis/dissertation fee.

After completion of the research work by a student, if the major advisor/advisory committee is of the opinion that the thesis/dissertation has IPR value, then it should be communicated to the Dean, Postgraduate Studies for action to protect the University interest and in such casesthe thesis/ dissertation will be evaluated by the following Standing Committee, internally:

i) Dean, Postgraduate Studies Chairman

ii) Director of Research

iii) Incharge, TM&IPR Cell

iv) Advisory Committee of the student

Project report of MBA/MBA (AB) will be completed in IV semester and will be submitted to the Head of the Department by 30th April along with submission fee prescribed by PAU for submission of project report. In case the student does not submit the project report within stipulated time, in addition to 'submission fees', a late fee of Rs. 4000/- will be charged up to 31st May. In case he/shefails to submit the project report in prescribed format by 31st May, the student will have to register for the next semester. In case student registers for V semester, last date of submission will be 30th September with a regular submission fee, and with late fee of Rs. 4000/-, the last date would be 31st October. Under no circumstances, the student will be allowed to submit final project report after 31st May of IV semester/ 31st October of V semester, respectively. Final viva-voce examination (regular) will be conducted during the first week of May in IV semester and 1st week of November in V semester every year by calling expert(s), respectively, after paying regular viva-voce fee. The number of experts will be decided by Head of Department. The viva-voce committee will consist of oneexternal examiner and the advisory committee members alongwith the Head of Department. On a request of the student and with the permission of Head of Department, special viva-voce can be arranged for which, the student will have to deposit special viva-voce fee of Rs. 7500/- to meet the expenses. In case the student fails to clear the viva-voce examination, it will be dealt as per clause 6.0 of PG Instructions of RIB.

**7. Study Leave and Rejoining Duty by Inservice Candidates**

An in-service candidate proceeding on study leave in India shall be required to fill in a bond that he/she will refund leave salary paid to him/her if he/she does not complete Ph.D. He/ she shall be allowed to rejoin duty only after submission of the thesis/dissertation. He/she will remain on study leave followed by leave of the kind due to him/her. Once a person joins a programme, he/she continues to be a student till he/she submits the final thesis. A person shall not be a member of the staff working job and be a student simultaneously. Similarly, the in-service candidates other than those of PAU must also complete their course work and research and submit the final thesis before joining their duties.

In case of in-service candidates of PAU, at the end of three years of study leave, the advisory committee alongwith Dean, Postgraduate Studies and Dean/Director/Controlling Officer of the in-service candidate, shall review the progress of the academic programme and research work conducted giving a critical assessment. Based on this assessment, a recommendation will be made to the Vice-Chancellor mentioning the approximate period for which further extension may be granted to the in-service candidate, or the leave of the kind due as provided in the rules may be sanctioned.

**8. Collaboration with other universities/institutes/industry**

To check inbreeding and to avail expertise available outside PAU, a number of MoUs/Agreements have been signed between PAU and other national and international universities/educational institutes/industry from time to time which facilitate the PG students to study and to conduct research therein. The detail of these MoUs is available in the office of the Registrar, Dean, Postgraduate Studies and the concerned Heads of the Departments of the University. Many PG students of the University and those from other universities/institutes have been benefitted by these MoUs/agreements. Ph.D. students can have scientists from abroad as member of advisory committee/ Co-Major Advisor. Electronic media such as Skype/video conferencing may be used for holding various meetings, discussions, guiding the students, etc, involving the member from abroad during the interaction. The provision for Co-Major Advisor from abroad shall be made only in cases where a student is to conduct a part of his/her research abroad in the concerned institution/university under the supervision of the scientist who is to be included as Co-Major Advisor.

SECTION V

# FINANCIAL ASSISTANCE

## 1. Scholarships

The Punjab Agricultural University (PAU) awards merit scholarships to its bonafide undergraduate and postgraduate students every year.

### 1.1 Eligibility

The scholarships shall be awarded to the first year students on merit on the basis of highest score in the merit list prepared for admission by the Registrar.

**Note:**

1. In case two or more students have the same grade point average/percentage of marks in the entrance/ qualifying examination and are bracketed for the last scholarship, they shall share it equally.
2. In case a scholarship is surrendered during/after end of the academic year on account of the award of the ICAR or any other scholarship, it is awarded to the next eligible student with retrospective effect provided the student to whom it is awarded is on the rolls of the University.

In the case of students having the same percentage of marks in the entrance examination, their merit in the qualifying examination will be taken into account for determining the relative merit for the purpose of award of merit scholarships.

### 1.2 Number and Value of Scholarship

The total number of scholarships for each class in College of Agriculture (COA), College of Agricultural Engineering & Technology (COAET) and College of Community Science (COCS) shall be approved by the Academic Council/Board of Management from time to time. The value of each scholarship for the undergraduate classes shall be Rs.500/- per month.

### 1.3 Duration of Scholarships

**1.3.1** The scholarships awarded to the first student shall be tenable for one academic year subject to the student maintaining an overall credit point average (OCPA) 7.00 (10.00 basis) in each semester. If in any semester, he/she falls below the limit, he/she shall lose the scholarship. The scholarship, thus vacated shall be re-awarded to the student with the highest OCPA at the time the scholarship is vacated, from amongst the non-scholarship holders in the class concerned. It shall be re-awarded with effect from the beginning of the second semester and shall be tenable for the remaining part of the academic year.

**1.3.2** For the subsequent years, the scholarship shall be re-awarded at the beginning of the academic year on the basis of credit point average (CPA) of the previous year.

**1.3.3** In order to be eligible for consideration for the award of scholarship, a student must have completed a minimum of 30 credit hours in the previous year in the first attempt.

**Note:**

i. For counting the credit hours, the total credit hours taken by a student including credit and non-credit courses shall be taken into account.

ii. The candidate having improved credit points through Supplementary/ Compartment Examination will not be considered for the award of scholarship.

**1.3.4** The payment of scholarship shall be made to the students for 12 months except the final year students who will be paid upto the end of the scheduled regular final examination of the second semester.

**1.3.5** In case a student who has been awarded the merit scholarship migrates from one college to another within the University, he/she may be allowed to take his/her scholarship along with him/her to the new college for that year and the amount of that scholarship shall be debited to the budget of the college from which he/she was drawing the scholarship before his/her migration. If he/she was not getting any scholarship

before migration, he/she shall not be entitled to it for that year in the College to which he/she migrates if his/her academic achievements during the previous year were better than those of the recipients of the scholarship in the new college.

**1.3.6** A student who had been dropped, shall not be eligible for scholarship on re-admission to same college during that year. However, if he/she is admitted to another college, he/she shall be eligible for scholarship on merit.

**1.4 Selection of Scholars**

The Dean of the College concerned shall prepare a merit list for the award of scholarships which will be displayed on the notice board of the college. After considering objections, if any, the Dean shall offer the scholarship to as many students in order of merit as there are scholarships provided that such offers shall be made in writing. If a student does not inform the College in writing of his/her acceptance of scholarship within two weeks of the intimation, his/her claim to scholarship shall be liable to be forfeited. If a student does not accept the scholarship, it shall be awarded to the next student in order of merit provided he/she fulfils the conditions prescribed.

**1.5 Withdrawal of Scholarships**

Scholarships shall be awarded on the express understanding that the student shall pursue his/her studies with interest. If it appears at any time that the student has been guilty of gross misconduct, his/her case shall, after due warning, be reported by the Dean of the College concerned to the Academic Council which may withdraw it.

**1.6 General Conditions**

**1.6.1** A student who has been awarded a scholarship shall not be debarred from a loan scholarship or sports scholarship.

**1.6.2** A nominee from a state other than Punjab shall not be eligible for a scholarship if he/she is already getting a scholarship other than a loan scholarship from his/her state.

**1.7 Scholarship by Outside Agencies**

The University may accept scholarships offered by the Central/State Government or any other agency. These scholarships shall be additional to the number of scholarships awarded from the University resources. A student is eligible to receive only one scholarship at any given time.

## 2. Stipends

The PAU shall award stipends to bonafide students admitted to Ph.D. programmes every year.

**2.1 Eligibility**

A stipend of Rs.1000/- per month shall be payable to a student enrolled for Ph.D. programme in the University who is not in receipt of any fellowship or leave salary on fulfillment of the prescribed conditions. The duration of the stipend shall be five semesters.

**2.2 General Conditions**

A student who fails to obtain an OCPA of 7.00 (10.00 basis) at the end of a semester during the Ph.D. programme shall not be paid stipend for the following semester. However, when he/she subsequently obtains an OCPA of 7.00 (10.00 basis), the stipend may be paid from the following semester.

## 3. Fellowships

The PAU shall award every year, Merit Fellowships and Senior Fellowships for Master's and Ph.D. students, respectively.

**3.1** Master's Programme: Merit Fellowships shall be awarded to the first year students on the basis of their performance in the respective entrance examination. In the case of students having the same percentage of marks in the entrance examination, their merit in the qualifying examination will be taken into account for determining the relative merit for the purpose of award of merit fellowship.

**3.2** Ph.D. programme: Senior Fellowships shall be awarded on merit in the first instance only to those students who have completed their Master's degrees from the Punjab Agricultural University on the basis of OCPA/ OGPA with a minimum OCPA of 7.25 (10.00 basis) or equivalentOGPA in Master's degree. If no student is eligible under this category, the fellowship shall be awarded to the students admitted from other institutions on merit on the basis of OCPA/OGP Apercentage of marks obtained in the Master's degree subject to the fulfillment of minimum OCPA/OGPA requirements.

**Note:**

1. In case a Merit Fellowship or Senior Fellowship is surrendered during or after the end of the academic year on account of the award of the ICAR or any other fellowship, the fellowship thus surrendered shall be awarded to the next eligible student on merit with retrospective effect provided he/she is on rolls of the University.
2 In case two or more students have obtained the same OCPA/OGPA/Percentage of marks in the entrance examination and qualifying examination and are bracketed for the fellowship, they shall share it equally.

**3.3 Number and Value of Fellowships**

The total number and value of fellowships for each class shall be as under unless otherwise decided by the Academic Council/Board of Management:

| College | Programme/Class | No. of Fellowships | Value of Fellowship (Rs.) |
|---|---|---|---|
| **MERIT FELLOWSHIP** | | | |
| College of Agriculture, Basic Sciences & Humanities, Community Science and Agricultural Engineering & Technology | M.Sc./MBA/MBA (Agri. Business)/ M.Tech. 1st and 2nd year | One fellowship in each discipline for the first 7 students and one additional fellowship for every 7 additional students or a part thereof provided the number of students is not less than 3. | Rs.2000/- per month each |
| **SENIOR FELLOWSHIP** | | | |
| College of Agriculture, Basic Sciences & Humanities, Community Science and *Agricultural Engineering & Technology | Ph. D. | One Senior Fellowship in each discipline. | Rs.3000/- per month |

*The Centre offers a limited number of fellowships @ Rs.700.00 p.m. to M. Tech. students and @ Rs.850/- p.m. to Ph.D. students subject to the fulfillment of certain conditions during the period of their studies.

**Note:**

1. As per existing provision, one fellowship in each discipline for the first seven students and one additional fellowship for every seven additional students or a part thereof be awarded in Master's programme. The scholarship to undergraduate students may also be determined on the basis of the admission made in the first year of a programme and the same number to continue for the duration of the programme. However, for counting the number of students for the award of fellowship/scholarship, the candidates admitted under the ICAR quota who are awarded fellowship/scholarship by the ICAR will not be counted while calculating the number of fellowships/scholarships.
2. Even if there is only one student admitted in any discipline of all the constituent colleges of the University and is eligible for the award of Senior Fellowship, he/she is to be awarded the same.
3. The award of Merit Fellowships shall be so regulated that if in a discipline one or more fellowship have been awarded depending on the number of students in that department, the number of fellowships shall not be reduced /enhanced if subsequently some students leave /join the programme.

4. The candidates admitted against additional seats (except Kashmiri Migrants, ICAR Nominees - with/ without JRF/SRF, Sports Men/Women and GOI nominees) shall be counted for calculating the number of fellowships/scholarships and considered for award of University Merit Fellowships/Scholarships or any other concession in all the teaching programmes of the University at postgraduate level.

## 3.4 Duration of Fellowships

**3.4.1** The Merit Fellowships for each discipline shall be tenable for two years. The fellowship awarded to the first year class as per conditions laid down in clause shall continue for one academic year subject to the student maintaining an OCPA of 7.00 (10.00 basis). If at the end of first semester his/her OCPA falls below this limit, he/she shall forfeit the fellowship. The fellowship falling vacant in this or any other manner, shall be re-awarded to a student, with the highest OCPA at the time the fellowship is vacated from amongst the non-fellowship holders of the class in the Department concerned subject to fulfillment of the prescribed conditions.

**3.4.2** In the beginning of the second year, the fellowships shall be re-awarded for the next academic year on the basis of OCPA at the end of the second semester provided the student has completed a minimum of 22 credit hours excluding non credit courses and research credit hours.

**3.4.3** The payment of fellowships shall be made for 12 months except that students of the second year shall receive the fellowships only up to the end of the second semester or 12 months whichever is earlier.

**3.4.4** The Senior Fellowships for each class of the discipline shall be tenable for five semesters, provided that the Dean, Postgraduate Studies may extend the duration of a fellowship in a particular case for a period not exceeding one semester. The student should apply for extension within one month of his registration for the 6th semester giving specific reason through his Major advisor and Head of the Department. The extension may, however, be allowed only to a student who was in receipt of fellowship during fifth semester. The total duration of the fellowships, however, shall not exceed 36 months from the date of commencement of the programme or till the submission of thesis whichever is earlier.

**3.4.5** The fellowship awarded to the first year class as per condition laid down in clause shall continue for one academic year.

**3.4.6** In the beginning of the second year the fellowship shall be re-awarded for the second year to the student having the highest OCPA (but not less than 7.25 (10.00 basis)) provided he/she has successfully completed two semesters. The fellowship shall be re-awarded for the fifth semester to the student having the highest OCPA provided he/she has successfully completed four semesters.

**3.4.7** The awardees shall hold the fellowship for a period of one academic year/semester (for the third year class) subject to maintaining an OCPA of 7.25 (10.00 basis).

**3.4.8** If at the end of a semester, the fellowship holder fails to maintain an OCPA of 7.25 (10.00 basis), the fellowship shall be withdrawn with effect from the commencement of the following semester.

**3.4.9** The fellowship falling vacant in this or any other manner during the academic year shall be awarded to the student having the highest OCPA (but not less than 7.25 (10.00 basis)) from the date it falls vacant to the end of the academic year.

**3.4.10** The payment of the fellowship shall be made for 12 months except that the third year student shall be paid only up to the end of V / VI semester.

## 3.5 Selection of Fellows

The Dean, Postgraduate Studies prepare merit-cum-award list (provisional) and send to the concerned Departments seeking objections, acceptance of awards and the certificate regarding non-receipt of financial assistance on the prescribed proforma. Those who are in service/sponsored candidates and on leave with pay or are in receipt of any financial assistance shall record such facts in this certificate. The Dean will finalize the merit-cum-award list after examining the objections, if any and other facts. If the requisite information is not received from the Head of the Department within 15 days, the fellowship of the Department shall be liable to be forfeited. If a student declines the fellowship in writing, it shall be awarded to the next student in order of merit, subject to fulfillment of prescribed conditions.

**3.6 Cancellation or Reduction of a Fellowship**

**3.6.1** Fellowship shall be awarded on the express understanding that the student shall pursue his/ her study diligently. If it appears at any time that the student has been guilty of gross misconduct, his/her case shall, after due warning, be reported by the Dean, Postgraduate Studies, tothe Academic Council which may withdraw the fellowship.

**3.6.2** If during the currency of a semester, the holder of a fellowship is not regular in studies, the fellowship may be awarded to the next student on merit on the recommendations of the Head of the Department concerned. If a postgraduate student who has been awarded Merit Fellowship or Senior Fellowship is not able to maintain the minimum prescribed OCPA and loses the fellowship or is dropped from the programme, he/she shall not be eligible for the award of fellowship on re-admission in the same or different programme. A student who obtains theminimum prescribed OCPA and dropped under rule 7.6.4 (d) due to US grade in research for two semesters continuously, and if allowed to continue during the subsequent semester will, however, be considered for the award of fellowship/stipend subject to fulfilling the required conditions.

## 3.7 General conditions

**3.7.1** A student who has been awarded a Merit or Senior Fellowship shall not be eligible for any other fellowship, stipend/scholarship/leave salary from the University or from any other source.

**3.7.2** The award of fellowship shall be so regulated that in each discipline where general admission is made from a semester other than the regular one, the academic year shall be deemed to commence from that semester for the award of fellowship/stipend. In other cases, the fellowship/stipend shall be awarded on the basis of regular academic session. The students got registered late by one semester after the general admission will not be considered for award of fellowship/stipend.

**3.7.3** The improved credit point through the supplementary/ compartment examination or repeating the course or by any other means, shall not be considered for the award of Fellowship/ merit scholarship in any of the subsequent semesters.

**3.7.4** If a student, after the award of fellowship, migrates to other discipline/subject, within the University, he/she shall not be entitled to hold the fellowship of the previous discipline/subject. If he/she was not getting any fellowship before his/her migration, he/she shall not be entitled toit for that academic year (two semester) in the discipline/subject to which he/she has migrated even if his/her academic achievement during the previous year were better than those of recipients of the fellowships in the new discipline /subject.

**3.7.5** The University fellowships and stipends are governed by the set academic standards and are processed according to the rules. However, in case of dispute the Dean, Postgraduate Studiesmay decide that case of award on merit for the vacant fellowship(s) or stipend(s).

**3.7.6** If a student leaves the study after attending requisite number of classes, the fellowship availed by him/her may not be recovered. The fellowship may be awarded to another student from the next semester.

## 4. Sports Scholarships

**4.1** The PAU shall award every year sports scholarships for major games of Hockey, Football, Athletics and Cricket, and minor games of Basketball, Lawn Tennis, Swimming and Water Polo, Vol leyball, Badminton, Cycling, Handball, Kabaddi, Shooting, Table Tennis, Weight Lifting Power Lifting and Best Physique.

**4.2 Eligibility**

The students for their proficiency in sports shall be eligible for the sports scholarships, themerit of which shall be evaluated as given in Annexure - A.

**4.3 Number and Value of Scholarships**

The total number and value of scholarships shall be as follows unless otherwise decided by the Academic Council/Board of Management:

| Name of the Game | Number of Scholarships | Value of Scholarship |
|---|---|---|
| (a) Major Games: Hockey, Football, Athletics & Cricket | 4 | Rs 350/- each |
| (b) Minor Games: Basketball, Lawn Tennis, Swimming, Table Tennis, Volleyball, Badminton, Cycling, Handball, Kabaddi, Shooting, Weight Lifting Power Lifting and Best Physique. | 6 | Rs 350/- each |

**4.4 Duration of Scholarships**

The scholarship shall be tenable for one academic year subject to the student maintaining his/her proficiency in the respective game and at the end of the year the scholarship may be re-awarded to the best student on the basis of performance in the respective game.

**4.5 Selection of Scholars**

There shall be a committee for the selection of sports scholarship as under:

| | | |
|---|---|---|
| i) | Director Students' Welfare | Chairman |
| ii) | Presidents of the Sports Committees | Members of the constituent colleges |
| iii) | Secretaries of the Sports Committees | Members of the constituent colleges |
| iv) | Deputy Director Sports | Member - Secretary |

**4.6 General Conditions**

A student who has been awarded a Sports Scholarship shall not be debarred from academic merit fellowship/ scholarship or stipend or any other financial assistance from any source.

**4.7 Cancellation or Withdrawal of Sports Scholarship**

Sports Scholarship shall be awarded on the express understanding that the student shall maintain his/her proficiency in the respective game. If it appears at any time that the student is not maintaining his/her proficiency or has been guilty of gross misconduct, he/she shall be given a warning by the Director Students' Welfare/Dean and the case shall be put before the Academic Council who may reduce the amount of scholarship or withdraw it completely depending upon the nature of offense.

# ANNEXURE - A

## Criteria for the award of sports scholarship

The students for their proficiency in sports shall be eligible for the sports scholarship, the merit of which shall be evaluated as under in the respective games for the academic year under consideration

**Sr No. Description Marks**

**International level**

| | | |
|---|---|---|
| i) | 1st position | 100 |
| ii) | 2nd position | 95 |
| iii) | 3rd position | 90 |
| iv) | Participation | 85 |
| v) | Attended coaching camp but not selected in the National Team | 55 |

**Senior National/Combined Universities**

| | | |
|---|---|---|
| i) | National Record Holder | 67 |
| ii) | 1st position | 65 |
| iii) | 2nd position | 60 |
| iv) | 3rd position | 55 |
| v) | Participation | 50 |
| vi) | Attended coaching camp but not selected in the Sr State/Combined Universities Team | 40 |

**All India Inter-Varsity Level**

| | | |
|---|---|---|
| i) | Inter-Varsity Record Holder | 62 |
| ii) | 1st position | 60 |
| iii) | 2nd position | 55 |
| iv) | 3rd position | 50 |
| v) | Participation | 38 |

**Junior National/Combined Universities**

| | | |
|---|---|---|
| i) | Junior National Record Holder | 57 |
| ii) | 1st position | 55 |
| iii) | 2nd position | 50 |
| iv) | 3rd position | 45 |
| v) | Participation | 40 |
| vi) | Attended coaching camp but not selected to represent the Jr. State | 30 |

**Zonal Inter-Varsity/All India Inter- Agril. Universities/Intt-Distt Level**

| | | |
|---|---|---|
| i) | State Record Holder | 52 |
| iii) | 1st position | 50 |
| iv) | 2nd position | 45 |
| v) | 3rd position | 40 |
| vi) | Participation | 35 |

**University Level/ Junior Inter-Distt Level**

| | | |
|---|---|---|
| i) | University/Junior State Record Holder | 32 |
| ii) | 1st position | 30 |
| iii) | 2nd position | 25 |
| iv) | 3rd position | 20 |
| v) | Participation | 15 |

***Participation in Olympic, World Championship, World Cup, Commonwealth Games, Asian Games, Asian Championship, Asia Cup**

**Note:**

i) In case a student is placed on scholastic probation or does not meet the minimum requirements, he/she shall not be eligible for the award of the University Sports Scholarships.

ii) In case no student is eligible for scholarship in one game, the scholarship shall be transferred to the other major/minor game for award to the deserving students.

iii) Sports person having distinction in sports in this University shall only be eligible for applying for the award of the University Sports Scholarships.

iv) Highest position/category shall only be considered for determining the merit for the award of sports scholarship. In case of a tie, the second best position/category and so on, shall be taken into account till tie breaks. However, if tie remains, then candidate with higher OCPA shall be considered. If still tie remains, then candidate elder in age shall be considered.

v) Incomplete application in any respect including attachment of certificates will not be entertained.

Sports scholarship shall be given with the explicit understanding that the sports person shall continue to play his/her game regularly.

SECTION VI

# SEMESTER SYSTEM AND SEMESTER RULES

## Introduction

The semester system of education was introduced in this University from the academic year 1988-89. In this system, the annual centralized examinations are substituted by the teaching of subjects spread over a period of 21 weeks, called a semester. It is the teacher who grades his students on the result of various tests and assignments. This system inculcates the habits of punctuality and hard work among the students and reduces the percentage of failures in the examinations, as it divides the courses of study into smaller units which can be cleared by the students during a semester. At the end of semester, semester reports indicating the performance of the students are prepared by the Registrar's office for distribution to the students, Deans and the Advisors concerned. A copy of the semester report is also sent to the parents of the students at the end of each semester.

## SEMESTER RULES

**1. Academic Year and Semester Calendar**

**1.1** The academic year shall ordinarily be from July to June. It shall be divided into two semesters of 21 weeks each. There will be a summer session for graduating students. The students can register for a credit course of maximum 4 credit hours during summer session. The courses will be offered on the request of the graduating student(s) and if offered, can be registered by the other students also. The semester calendar for each academic year shall be issued by the Registrar's office during the second semester of the previous year.

**2. Admission: Registration for First Semester**

**2.1** Admission to a programme, which shall be made by the Registrar, shall include selection after entrance test and/or counselling/interview, payment of the prescribed fees and registration for first semester.

**2.2** Admission to all undergraduate programmes of the University shall be made in the beginning of the first semester of the academic year only.

**2.3** Admission to Master's programme shall be made in the beginning of 1st semester. Admission to Ph.D. will be done from the 2nd semester. No admission will be made in the subsequent semesters for both the programmes.

**2.4** A selected candidate shall pay his/her fees for admission and get himself/herself registered within the prescribed date which, normally, shall not be later than the working day immediately preceding the date of commencement of course work. However, the Registrar may, on the recommendation of the concerned Dean, permit the late admission of a candidate up to the working day immediately following the expiry of one week from the date of commencement of the course work.

**2.5** Unauthorised absence during the registration at a programme at the time of admission shall be treated as a serious lapse and for this lapse, fine as prescribed will be charged.

**3. Registration for Subsequent Semester**

**3.1** Registration for the first semester of a programme is a part of the admission procedure and is governed by the admission rule noted above. Registration for the subsequent semester shall be governed by the following schedule :

a) Advisement & Registration — On the date of registration.

b) Registration with late fee — Up to three working days from the date of registration.

Under exceptional circumstances, the Dean may waive off the late registration fee upto three working days from the date of registration.

Further under exceptional circumstances the Registrar may, on the recommendation of the Dean concerned, allow a student to register after the last date fixed for registration in each semester up to the last date for adding a course.

**3.2** Unauthorised absence from the advisement programme will be treated as a serious lapse and for this lapse, a late fee will be charged. If during the day of registration, a student happens to be outside the University in connection with his/her studies, field work, research or due to other unavoidable and legitimate circumstances, he/she may be permitted to register himself/ herself in absentia through his/ her advisor/major advisor by submitting registration cards and paying fees with the prior approval of the Dean concerned.

**4. Change of Course**

Application for change of course including any addition or withdrawal shall be made in the prescribed form alongwith prescribed fee in accordance with the instructions given on the back of the form provided, however, the exemption from this fee may be granted by the Dean when the change of course is necessitated by administrative considerations.

The last date for adding a course shall be the working day immediately following the expiry of three weeks from the date of commencement of the semester. The last date for withdrawal of the course shall be the working day just prior to the date of commencement of mid-term examinations.

***Note :*** Student who adds a course after the start of the semester will not be allowed to withdraw that course.

**5. Advisory System**

**5.1 For Undergraduate Students**

Each student shall be assigned to an advisor by the Dean at the time of the student's admission. The advisor shall help the student in planning the programme of his/her studies and in the choice of courses. He/she will also help in determining the credit load which the student can safely and conveniently carry in each semester and advise him/her regarding addition or withdrawal of courses. Students are expected to attend regularly advisory group meetings and keep constantly in touch with their advisors so that the advisor may watch their progress and guide them along right lines. Where an advisor finds that his student is not making adequate progress in a certain course, he/she may ask him/her to withdraw that course. The advisory group meeting in all the colleges shall be fixed on the same day and at the same time.

**5.2 For Postgraduate Students**

A major advisor shall be assigned to each postgraduate student within 2 months of admission by the concerned Head of the Department keeping in view the recommendations of the Departmental Academic Affairs/Teaching Committee and approved by the Dean, Postgraduate Studies. Besides, there shall also be an Advisory Committee for each student which will be appointed by the Dean, Postgraduate Studies, on the recommendations of the Advisor, through the Head of the Department. The members of the Advisory Committee shall be chosen from the postgraduate faculty.

For a student preparing for the Master's degree, the Advisory Committee shall consist of two members of the faculty representing the major subject. One of them will be the major adviser who will also be Chairman of Committee. The third member shall represent the minor subject provided, however, that the Dean, Postgraduate Studies may add one or more members to the Committee.

**For students preparing for Doctorate degree, the Advisory Committee shall consist of :**

i) Two members representing major subject, one of them will be the major advisor who will alsobe the Chairman of the Committee.

ii) Atleast two members from outside the major discipline with atleast one from the minor field.

iii) One nominee of the Dean, Postgraduate Studies.

The Advisory Committee shall guide the student in the choice of courses in major, supporting and minor fields. With a view to enhance the quality, usefulness and to avoid repetition of research, each department shall fix priorities in advance in tune with the overall research priorities decided for the department at university level. Within these, the research problems of individual students be finalized by a committee consisting of Major Advisor, Head of Department, the Chairman of the Research Committee of the Department alongwith the Advisory Committee of the student. The student will also be associated in this exercise. The details of the programme of study (synopsis) prepared by the Advisory Committee shall normally be submitted to the Dean, Postgraduate Studies before the start of the Mid Semester Examination of the 2nd Semester.

## 6. Evaluation

### 6.1 Evaluation of Course Work

The evaluation of student's achievements in a course shall be based on his/her performance in various kinds of tests, laboratory and library assignments, special problems, seminars and other types of exercises. The relative weightage to be given to these shall not be rigid and shall be determined by the instructor in consultation with the Head of the Department.

Every instructor shall prepare, in addition to his course outline for his teaching, a scheme of examination for his course and he shall submit this scheme to the Dean through the Head of his Department. This scheme of examination must include the mid-semester examination, the end of semester examination and atleast one evaluation short test/written test/assignment before the mid-semester examination the result of which shall be declared within six weeks after registration.The external evaluation system of the end of semester examination for all the undergraduate programmes has been prescribed with effect from the academic session 2005-06 onwards. Some of the different types of tests which may be employed by the instructor are described below :

**(a) One Hour Test**

This is written test lasting for about an hour. The date of the test and the subject matter to be covered in the test shall be announced atleast one week in advance.

**(b) Mid-semester Examination**

During the 11th week of each semester, there shall be an examination in each course lasting for atleast one hour. This examination shall be scheduled by the Registrar during each semester. The probable date of examination and the subject matter to be covered therein shall be announced by the instructor to the students. However, the make-up examination shall be completed by the end of 12th week of the semester. The teacher will submit the mid semester report to the Dean as per date scheduled by the Registrar.

**(c) End-of-semester Examination**

Towards the end of the semester, there shall be one examination in each course which shall last for atleast two hours and shall cover the entire subject matter of the course. A student must appear in the end of semester examination failing which he/she will be failed in that particular course. The examination shall be scheduled by the Registrar keeping in view that no student shall be required to appear in more than one examination in one day.

The external examination system will be restricted to the final Theory examinations of only credit courses while the Practical will continue to be conducted internally. The weightage of final examination of each course should not be less than 35 per cent of the total marks.

### 6.1.1 Make-up-Examination

If a student misses an examination (other than the end of semester examination) on account of illness or some other valid reason, he/she may file petition through his/her advisor and the instructor to the Head of the Department concerned within three working days from the completion of the examination. The examination on medical ground should be allowed as certified by the Senior Medical Officer, Civil Hospital or Medical Superintendents of Hospitals recognized by the PAU or Senior Medical Officer of Punjab Agricultural University Hospital. If the Head of the Department is satisfied that the student was prevented from appearing in the examination for valid reason, he/shemay direct the instructor to hold a special make-up examination for the student and endorse copyof his order to the Registrar with a copy to the Dean concerned for being included in the student's personal file. It will be the responsibility of the student to get in touch with his/her instructor and have a date fixed for the make-up examination.

Such a student shall be required to take up the make-up examination within 7 working days from the completion of examination.

The students who are deputed by the University to participate in various sports activities/Cultural Activities at Zonal/National or International level as authenticated by the Director Students' Welfare and also those students who are hospitalized during examination days as authenticated by the Chief Medical Officer, PAU/Civil Surgeon and the students who missed the examination on account of appearing for two courses in a session of the scheduled examination on a particular day, be given special examination (Theory or Practical or both) in lieu of final examination missed.

**6.1.1.1 Supplementary Examination - DELETED**

**6.1.1.1 (a) System of Compartment/Re-appear/Re-examination - only for undergraduate student(s)**

1. For a student to be eligible for the Compartment Examination, he/she
   i) must appear in end of semester examination.
   ii) must get pass marks in the Practical examinations and
   iii) must meet the prescribed attendance requirements for UG programmes in the university.
   iv) The students must have secured 35% marks each in mid-term and end of the semester examination to become eligible to take compartment.
2. The student will be allowed to take maximum 3 Compartment Examinations in one semester.
3. The fee of Compartment Examination will be as per PAU Prospectus.
4. Only one chance will be given for each Compartment Examination.
5. Compartment Examination will be conducted as per schedule given in academic calendar.
6. The students who come under dropping as per Semester Rule 7.6.4 (b) for UG students will be allowed to register without late fee after the declaration of results of compartment examination(s).

If he/she fails to meet the required OCPA under rule 7.6.4(b) as the case may be, after declaration of the result of compartment examinations, he/she will be dropped from the university permanently as per rule 7.6.4(b).

**6.1.1.2. Re-evaluation: This rule is applicable in final theory examinations conducted only under External Examination System.**

The number of courses for re-evaluation in a semester can be availed upto 50% of the number of courses registered or three, whichever is less, even if a candidate has passed the course in the final examination while considering eligibility for re-evaluation, based on 50% of registered courses, the fraction of 0.5 and above will be rounded off upwards. The student may apply for re-evaluation with prescribed fee within fifteen working days of declaration of the result in a prescribed proforma available in the office of respective Deans. The Coordinators of respective colleges (External Examination) shall get the re-evaluation done by an examiner other than the one who has already marked the answer book and submit the result to the Dean.

- The examiner for re-evaluation should be appointed by the Dean's office directly rather than getting it done from the concerned HOD. After receiving the application for re-evaluation, the Co-ordinator External Examinations should approach Dean for appointing an examiner for the same.
- The previously awarded marks should be hidden before handing over the answer sheet to the examiner.
- The examiner should check the answer sheet on the same day in the Examination Cell itself.
- There should be a capping of increased marks to the extent of 5% (out of end-of-term marks only), except in case of unchecked question(s) or error in totalling of marks.
- In case of a large difference in marks obtained before and after re-evaluation, the answer sheet may be got re-evaluated from another examiner to be appointed by Dean of the College and the final result be declared by the Dean on the basis of similarity of marks awarded by 2 examiners out of three.
- The Co-ordinator of External Examination after getting the re-evaluation done may get the same approved by the Dean of the College before sending the revised result to the teacher concerned.
- The whole process of re-evaluation needs to be completed within 3 working days of submission of the application.

**6.1.2 Award of Grades/Credit Points**

a) At the end of each semester, the instructor in each course shall, in consultation with the Head of the Department, grade his students on the basis of the cumulative results of different kinds of tests, examination and on the basis of performance of the laboratory and the library assignments, special problem and seminars and other types of exercises.

   The OCPA may be rounded off upto two decimal places after taking into account the third place of decimal as shown below :

**Per cent of marks obtained**

**Corresponding credit points**

| | |
|---|---|
| 99.0 | 9.90 |
| 98.0 | 9.80 |
| 97.0 | 9.70 |
| 96.0 | 9.60 |
| 95.0 | 9.50 and so on |

From credit points for different courses taken by a student in a semester, the credit points average (CPA) of the semester shall be calculated taking into consideration the credit hours of different courses. Similarly, the overall credit point average (OCPA) of the student shall be calculated taking into account the accumulated credit hours and the accumulated credit points. If an undergraduate student obtains less than 50.00 per cent marks in Theory as well as in Practical in a particular course, he/she shall be awarded 'F' grade. Similarly, if a postgraduate student obtains less than 60.00 per cent marks in Theory as well as in Practical in a particular course, he/she shall be awarded 'F' grade. No credit points shall be awarded for a course in which the student obtains 'F' grade. The student shall be required to repeat all the courses in which he/she has obtained 'F' grade for successful completion of the degree programme.

b) The Head of the Department concerned shall submit these credit points to the Dean concerned as well as to the Dean of the College for which the course has been offered. The Dean concerned shall discuss the credit points with Head of the Department concerned and finalize the result. It shall be the responsibility of the Dean concerned to send the credit points sheet to the Registrar.

c) If the credit point(s) of course(s) is /are not received by the Registrar in respect of a student upto the end of the subsequent semester, the student shall be automatically awarded 'F' grade in that/ those course(s) and the result declared accordingly unless intimation is received within this period from the concerned Dean that a particular result has been held up for reason to be specified in the communication.

d) The credit points sheets shall be kept as permanent record of the teacher of the Department and of the college for future reference.

**6.1.3 Significance of Grades**

In addition to the credit points, the significance of various grades shall be as follows:

| | | | | | |
|---|---|---|---|---|---|
| F | - | Fail | I | - | Incomplete |
| S | - | Satisfactory | US | - | Unsatisfactory |
| W | - | Withdrawn | NC | - | Non-Credit Course |

**6.1.3.1** In order to complete a course and earn the credit points corresponding to that course, a student is required to pass in Theory and Practical separately and must get a minimum of 5.00 (10.00 basis) credit points in case of undergraduate students and 6.00 (10.00 basis) credit points in the case of postgraduate students.

**6.1.3.2** A student who has failed in a particular course but has attended the requisite number of classes, may register for the same course(s) when it is offered as regular course(s) to the next class. It will be compulsory for such students to meet attendance requirements in Practicals alongwith regular class in this repeat course. However the attendance in Theory for such students will be optional. They will be required to appear in all the examinations/assignments etc. alongwith regular class. These courses will be designated as special courses. If a student taking a special course again fails he/she will have to take it subsequently whenever offered as a regular course and will have to meet all the requirements including attendance in Theory and Practicals as well as the examinations. The students may be allowed to register for special courses in a semester, within the maximum prescribed limit of credit load. The students on good standing may be allowed to register for one additional special course in addition to the maximum credit load.

When a student gets grade 'F' in a course, the credit points corresponding to that course shall not count for graduation requirements but the credits and credit points shall be taken into account for computing the credit point average subject to the provision of rule 7.6.3 only.

In order to avail the exemption of attendance in Theory classes of the special courses, the students shall have to apply to the Dean concerned through advisor within seven working days from the registration/ additions of the special courses after which the request for exemption of Theory classes shall not be entertained.

**Note :** No special courses will be offered. However, if needed special courses will be offered in summer session.

**6.1.3.3.** An instructor shall award 'W' in his course only to a student who has been permitted to withdraw from a course under Rule 4.

**6.1.3.4. (a)** Research work done at the postgraduate level may extend to two or more semesters. Pending the evaluation of the thesis and the final oral examination, the progress made during each semester shall be graded as 'S' or 'US'. If a student does not put in the required effort for the credits for which he/she was registered, the Major Adviser may either give him/her 'US' grade for the entire credit for which he/she was registered or may give 'S' grade for the reduced number of credits. Credits corresponding to research for the semester shall count towards graduation requirement only, if the student gets 'S' grade for research for that semester. 'S' and 'US' grades will also be awarded to indicate:

i) that a Ph.D. student has passed the preliminary examination.

ii) that a student has fulfilled the requirements of the rules regarding the three fold programme of NCC/ NSO/ NSS where applicable; and

iii) that a student has successfully completed the programme of Practical field-work, when it has been prescribed as a part of the graduation requirements.

**6.1.3.4. (b) Incomplete Grade**

When a student cannot complete the special problem/project on account of a valid reason the instructor may, award him/her 'I' grade which the student must clear subsequently.

**6.1.3.5** While sending the semester report to the parents/guardian of a student, the progress made by the student shall be indicated.

**6.1.4** Answer papers of all the tests and examinations except that of end-of-semester examination, shall be returned to the students by the instructors. After the end-of-semester examination, students may see the answer-books of the final examination held under Internal Examination& Evaluation System up to 15 days of the start of the next semester. The answer books of the final Theory examinations held under Internal Examination & Evaluation System should be kept by the concerned teachers for full two semesters following that in which the examination is conducted. After that period, the teacher may dispose off the answer books.

**6.1.4.1.** Where an instructor finds that he/she has made a mistake in reporting of the credit points achieved by a student, he/she shall immediately bring it to the notice of the concerned Dean. The Dean, after going through all the documents and satisfying himself/herself that there has been a genuine mistake, shall write to the Registrar recording the circumstances and giving the correct credit points. The Registrar shall accordingly issue a revised semester report. Such corrections should be reported to the Registrar within 15 days of the issuance of the semester report.

**6.2 Preliminary Examination for Ph.D.**

There shall be a preliminary examination for Ph.D. students to be held on successful completion of atleast 75 per cent of the course work. The preliminary examination shall include a written examination followed by an oral test. The written examination shall consist of two papers, one in the major field and the other in the minor field. The Major Advisor shall be responsible for conducting the written examination in the major field in consultation with the teachers who have offered various courses related therewith. The written examination in the minor field shall be conducted by the advisory committee member representing the minor field. The question papers shall be so designed that these tests, the overall comprehension of the student in the major/minor field and are not restricted only to the courses studied. The process of written examination of both major and minor fields shall be completed within a month after the start of first examination and the result communicated to the Dean, Postgraduate Studies within 10 days thereafter.

The oral examination shall be conducted by the Student's Advisory Committee along with the Head of the Department and with an additional member from outside the University who shall be chosen by the Dean, Postgraduate Studies, from a list of names submitted alongwith the result of the written examination to him by

the Head of the Department in the major field, provided that the Dean, Postgraduate Studies may appoint any person outside the panel recommended by the Head of the Department.

If a student fails in the preliminary examination, he/she shall be allowed to re-appear in the examination not earlier than three months after the first examination.

### 6.3 Evaluation of the Thesis and Final Examination for M.Sc/M.Tech./Ph.D.

The thesis shall be evaluated and the final oral examination conducted by an examining committee constituted as under:

i) Student's Advisory Committee.

ii) External Examiner(s) specialists in the student's major field to be appointed by the Dean, Postgraduate Studies from a panel recommended by the Head of Department. Provided that the Dean, Postgraduate Studies, may appoint any person outside the panel recommended by the Head of the Department. The oral examination of M.Sc/M.Tech/Ph.D. students shall be conducted by the external examiner and the Advisory Committee alongwith the Head of the Department.

**Procedure**

i) Thesis Writing: The thesis writing shall be approved only after a seminar is delivered by the student presenting all the data and its analysis. After the approval by the Advisory Committee on the quantum of work done, the thesis writing shall be taken up by the student.

ii) The reliability and authenticity of experimental results of thesis, projects shall be the exclusive responsibility of the student and the Major Advisor, rather than any other member of the Advisory Committee.

iii) The thesis shall be first sent to the External Examiner for evaluation. In the case of Ph.D. students there will be two external examiners for the evaluation of Ph.D. dissertation, out of two, one external examiner as recommended by Dean, Postgraduate Studies shall conduct viva-voce. The Examiner shall submit a report commenting on the thesis and indicating whether examiner recommends its acceptance or rejection. If the examiner recommends acceptance, then the oral examination of M.Sc./M.Tech./Ph.D. students shall be conducted by the external examiner and the Advisory Committee alongwith the Head of the Department. If the Examinerrejects the thesis, his/her evaluation report shall be placed before the Advisory Committee and Head of the Department for a decision. If the Advisory Committee alongwith the Head of the Department accepts the recommendations then the thesis will be rejected. If the Advisory Committee alongwith Head of the Department does not agree with the verdict of the external examiner then the thesis shall be re-examined by another external examiner whose decision for conducting oral examination as above or not shall be final.

iv) The Head of the Department shall in no case withhold the draft of thesis but can send his/her comments, if any, while forwarding the thesis to the Dean, Postgraduate Studies after which Dean shall settle the matter as per the procedure laid in para (iii) above.

v) Approval of the Thesis Draft : The draft of the thesis shall be submitted to the members of the Advisory Committee on any date before submission to the Dean PGS. However, the draft of the thesis shall be submitted to the Dean PGS at least ten days before the actual submission of the final thesis/dissertation. A certificate to this effect shall be given to the Dean at that time by the members of the Advisory Committee and such thesis will be accepted provided other formalities have also been met with. The preliminary examination should have been passed at least six months before the submission of thesis.

vi) The thesis shall be first sent to the External Examiner(s) for evaluation. He/she shall submit a report commenting on the thesis and indicating whether he/she recommends its acceptance or rejection. If he/she recommends acceptance, then the oral examination shall be arranged. If he/she rejects the thesis, his/her evaluation report shall be placed before the Advisory Committee for a decision. If the Advisory Committee accepts the recommendations, then the thesis shall be re-examined by another external examiner whose decision for conducting oral examination or not, shall be final.

vii) If the thesis is not accepted or the performance of the student in the oral examination is found unsatisfactory, the student shall have to re-submit the thesis or re-appear in the oral examination, in the following semester (not earlier than three months).

A student who fails to appear in the final oral examination should apply for arranging a fresh examination through the Head of the Department. If the circumstances are beyond the control of the student, the Dean, Postgraduate Studies may permit the re-examination within the same semester. If, however, the Dean, Postgraduate Studies is not satisfied with the circumstances stated by the student, the student shall register for one more semester and the examination shall be arranged on the payment of thesis dissertation re-submission fee.

**6.3.1** There shall be an oral examination for MBA and MBA Agribusiness candidates, which would be held at the end of 4th semester of the study programme or on successful completion of the course and research project, whichever is later. Project report is to be completed in 4th semester and will be submitted to the Head of the Department by 31st May (without late fee)/ 7th June (with late fee of Rs.4000/-) along with submission of fee prescribed by PAU for submission of project report. In case the student fails to submit the project report in prescribed format by 7th June, the student will have to register for 5th semester. In case the student registers for the 5th semester, the last date of submission will be 30th September (without late fee) or upto 31st October (with late fee of Rs.4000/-). The project report shall be first sent to the External Examiner for evaluation who would be a specialist in the subject and shall be chosen by the Dean, Postgraduate Studies from a list of names to be submitted to him/her by the Head of Department provided that the Dean, Postgraduate Studies shall have the power to appoint any person outside the panel recommended by the Head of Department. The Examiner shall submit a report commenting on the project report and indicating whether the Examiner recommends its acceptance or rejection. If the Examiner recommends acceptance then the oral examination would be conducted by the Student's Advisory Committee and the Head of Department. If the Examiner rejects the project report, his/her evaluation report shall be placed before the Advisory Committee and Head of the Department. If the Advisory Committee alongwith the Head of Department accepts the recommendations then the project report will be rejected. If the Advisory Committee alongwith the Head of Department does not agree with the verdict of the External Examiner then the project report shall be re-examined by the next external examiner on the panel whose decision for conducting oral examination as above or not shall be final.

The final viva voce examination will be conducted during the second week of June and first week of November every year by calling expert(s) in 4th / 5th semester, respectively. The viva-voce committee will consist of one external expert and one internal faculty member.

The oral examination will cover the entire course curriculum with special emphasis on the field of specialization and research project. If a student fails in the oral examination, he/she shall be allowed to re-appear in another examination, which would be held not earlier than three months after the first examination. The performance of the candidates will be recorded in a certificate of dissertation and oral examination for M.Sc./ Ph.D. candidates mutatis mutandis and submitted to the Registrar through the Dean, Postgraduate Studies. The failure of the candidate to appear in the oral examination will be regulated in accordance with the rule 6.3 (viii).

**6.4.1** In the programme of study, a student may be required to take such special courses as Seminar (591), Special Problems (592) etc. Seminar-591 of 1 credit hour will be compulsory for all Master's programmes and two seminars of 1 credit hour each will be compulsory for Ph.D. programme. The Advisory Committee shall specify the credits for Special Problems. However, a postgraduate student may be given a maximum of three credits. A special problem would be assigned to the student only when there are specific assignments for techniques of laboratory training to be undertaken by him/ her during a term. For such credits, the student is required to maintain a regular record of the workdone and to write a report at the end of his project. On the basis of the work done and report submitted, the student is graded 'S' or 'US' in Special Problem.

## 7. Graduation Requirements

### 7.1. General

The University has prescribed the minimum qualifications for admission to various programmes. But there may be candidates with qualifications similar to but not exactly the same as those mentioned in the minimum qualification but still may be considered by the University to be eligible for admission. There may also be students with pre-admission qualifications higher than the minimum prescribed. In all such cases, the pre-admission qualifications will be evaluated by a Committee. In the case of undergraduate programmes, it will be Academic Affairs Committee of the college concerned. In the case of postgraduate programmes, it will be the Student's Advisory Committee. The committee shall, after evaluating the deficiencies and/or additional attainments of the candidates (by holding a proficiency test if necessary), recommend additional courses and/or

grant exemption from certain courses.

**7.2** The residential requirements for completion of various programmes are as under :

| Number of Semesters | | | | | |
|---|---|---|---|---|---|
| **Sr. No.** | **Programme** | | **Normal** | **Minimum** | **Maximum** |
| 1. | Bachelor's 4-year | | 8 | 9 | 12 |
| 2. | Bachelor's 2+4 year | 2 year | 4 | 4 | 6 |
| | | 4 year | 8 | 6 | 12 |
| 3. | 5-year Integrated M.Sc. | | 10 | 8 | 13 |
| 4. | Master's | | 4 | 4 | 10 |
| 5. | Ph.D. | | 6 | 5 | 14 |
| 6. | Diploma 2-years | | 4 | 4 | 6 |
| 7. | Certificate course 1-year | | 2 | 2 | 4 |

**Note :** i) The residential requirement in the university shall include the stay at PAU and/or stay at its research stations and such other institutions/research stations with which the university enters into cooperative and collaborative arrangements.

ii) Period of discontinuation of study shall not be counted for calculating the maximum time limit of study period.

iii) If the student fails to complete his/her programme successfully within the maximum time limit prescribed for the programme as above, he/she shall no longer be a student of this University.

**7.2.2 Attendance Requirements for Undergraduate/Postgraduate Programmes**

All undergraduate/postgraduate students are expected to attend 100% lectures and Practical scheduled in each course. However, undergraduate students must have attended atleast 75% of lectures and Practicals in each of the courses except for various Experiential Learning Programme (ELP) courses for which minimum attendance requirement is 85% and the postgraduate students must have attended atleast 80% of lectures and Practicals in each of the courses failing that, he/she shall not be allowed to appear in the end-of-semester examination in Theory or Practicals of the course in which his/ her attendance falls short. This requirement of attendance is also applicable to credit hours for which postgraduate students have registered for research, failing which 'US' grade will be submitted for the total registered credit hours. The Instructors should send the names of the students having less than 75%/80% attendance (except for ELP courses), in their respective courses along with the Mid Semester Report of the concerned course.

**7.3 Credit Requirements of Graduation**

The minimum credit requirements for graduation under different programmes shall be prescribed by the Academic Council from time to time and published in the Resident Instruction Bulletin; subject to the provisions of rules 7.1 and 7.4.

**7.4 Transfer of Credits at Student's Entry/Exit**

When a student holding undergraduate degree from other university migrates to this University after having obtained his/her degree, no migration shall be necessary. When a student, with partial undergraduate degree from any other university (at least 1st year must have been completed) migrates to this University in-between ongoing batch of the same undergraduate degree programme, he/she shall be required to furnish a certificate regarding transcript of courses and credits taken in the previous University from the Head of the Institution in which he/she studied first. The academic records uploaded in the student's Academic Bank of Credit (ABC) may also be considered. Such migrating students must apply at least one month before the date of registration of the upcoming semester. When an undergraduate student migrates to this University from another University in the middle of programme, transfer of credits will be considered. This will be determined by a committee constituted by the Dean, which will examine the courses/subjects already studied by the student, the examination passed and the syllabi thereof. The overall credit point average of the student for the degree shall be determined based on jointly considering the courses undertaken by him/her in the preceding University as well as in this University and the credit points achieved in both the universities.

The undergraduate student seeking lateral migration/entry into PAU's on-going degree (i.e. entry with previous incomplete degree from other institutions) shall satisfy the following:-

1. The system of education in the institution from which the student is seeking migration and that of the PAU should be the same including the medium of instruction i.e. English.
2. The student seeking migration to PAU must have successfully completed at least one year study in the institution where he/she has been studying before seeking migration to this University. He/ she must have completed 1st year of the course/programme with overall credit point average of 7.00 (10.00) basis and above. He/She should not have been on scholastic/ conduct probation in the previous study programme and also should not have got 'F' grade. The migration fee as applicable shall be charged if a student is allowed to migrate from some other University to PAU.
3. The migration shall be restricted to the students from State Agricultural Universities (SAU's) and ICAR's Institutes/ ICAR's Deemed Universities/ICAR's Central Agricultural Universities.
4. The migration shall be allowed only against the vacant seats of the particular batch.
5. If there are more than one student seeking migration, the migration should be allowed strictlyon merit interse applicants for migration subject to fulfilment of prescribed conditions.
6. The student should apply for migration atleast one month before the start of a semester.
7. The student(s) admitted in this University through lateral entry shall pay all fee and funds, etc. as have been paid by the students of the particular batch at their admission. In subsequent semesters, these migrated students shall also pay semester fee and charges as are listed for that particular batch of the students.
8. The status of the student(s) from NRI will remain unchanged at the time of migration to this University.

   Such student(s) will have to pay the fees prescribed for the NRI for the particular programme and batch of this University. He/she will produce a certificate from his previous institution regarding the period he/she has studied. He/ She will also produce 'No Due' and 'No Objection' certificate alongwith his/her request for migration/entry to this University. The University will charge fees prescribed for NRI candidates for the subsequent period alongwith other dues of the University being collected from the students of general category.

**The undergraduate student seeking migration/exit from PAU with incomplete degree to any other University shall be subject to the following conditions:-**

i. He/She must have completed at least one year of the graduation programme at the PAU.

ii. He/She must have cleared all the courses of the first year of the degree curriculum at the PAU.

iii. Transfer of credits can be facilitated through Academic Bank of Credits (ABC) portal.

### 7.5 Normal, Maximum and Minimum Credit Load in a Semester

#### 7.5.1 For Undergraduates

In an undergraduate programme, the normal full-time programme of work in a semester shall be 18 credit hours. A maximum of 26 and a minimum of 12 credit hours may be taken by a student.

The undergraduate students on 'Good Standing' may be allowed to register a maximum of 28 credit hours (including special courses) from 3rd semester onwards of their programme provided these courses have been offered on regular basis.

***Note:-*** *Non-credit hours for NSO/NSS/NCC and courses offered during evening hours shall not be counted towards the maximum credit load limit.*

#### 7.5.2 For Postgraduates

In a postgraduate programme, the normal full-time programme of work in a semester shall be 18 credit hours. A maximum of 22 and a minimum of 9 credit hours may be taken by a student. The postgraduate students may be allowed to register for two extra credit hours than the prescribed maximum limit of credit hours during their final semester by the Dean, Postgraduate Studies provided the student is not on scholastic probation.

## 7.6 Minimum Credit Point Average Requirement

### 7.6.1 Requirement of GOOD STANDING for Graduation

The minimum overall credit point average requirement at the undergraduate level shall be 5.50 (out of 10.00) provided that the student must have taken minimum of 24 and 48 credit hours of courses at the end of 2nd and 4th semester respectively. The minimum overall credit point average required at the postgraduate level shall be 6.50 (out of 10.00). A student who has achieved this minimum requirement, shall be deemed to be on GOOD STANDING.

### 7.6.2 Scholastic Probation

If a student fails at the end of a semester to achieve the minimum standard prescribed under Rule 7.6.1 above, he/she shall be placed on SCHOLASTIC PROBATION during the semester immediately following.

### 7.6.3 Repeating Courses in order to fulfil the Minimum Requirement

An undergraduate student getting 5.00 to 5.49 credit points in a course may repeat that course with the prior permission of the Dean subject to the following conditions:

a) The repetition shall be allowed only once.

b) The repetition shall be permitted only to enable the student to fulfil the minimum credit point average requirement and not for the improvement of his/her credit point average or for enabling him/her to qualify for the award of a scholarship/fellowship or for competing for a Certificate of Merit or for a position in the University.

c) When a student repeats a course after getting grade 'F' or if permitted to repeat a course after getting 5.00 to 5.49 credit points, as the case may be, credits corresponding to that course shall be counted only once for the graduation requirements.

d) A student on scholastic probation be allowed to repeat a course only once and revised credit points shall be mentioned if there is improvement in the credit points, otherwise the original credit points shall stand. But in the official record of the student maintained in the Registrar's office, both the earlier and the credit points obtained after repetition improved or otherwise, shall be mentioned and the fact that he/she repeated the course shall be indicated by the letter 'r' written above the credit points which he/she obtained after such repetition. But till such time as the student repeats the course, the original credit points and credits shall be used to compute the overall credit point average.

   If a student, even after repeating a course with 5.00 to 5.49 credit points and after having studied all the courses prescribed for the given programme, does not obtain an OCPA of 5.50 he/ she shall be allowed to repeat the other course(s) in which he/she has obtained 5.00 to 5.49 credit points till he/ she obtains OCPA of 5.50 to complete his/her degree requirement subject to provision of semester rule 7.2.

e) The restriction contained in clause (a) of this rule shall apply in case of an undergraduate student, getting 5.00 to 5.49 credit points. An undergraduate or postgraduate student who is on good standing but who might get 'F' grade in a particular course, may be allowed to repeat that course without any such restriction.

**7.6.3.1** The postgraduate students getting 6.00 to 6.49 credit points may repeat that course with the prior permission of the Dean, Postgraduate Studies, subject to the following conditions:

a) The repetition shall be allowed only once at the end of the completion of the course work.

b) The repetition shall be permitted only to enable the student to fulfil the minimum credit point average requirement and not for the improvement of his/her credit point average or for enabling him/her to qualify for the award of a scholarship/fellowship or for competing for a Certificate of Merit or for a position in the University.

c) When a postgraduate student repeats a course after getting grade 'F' or if permitted to repeat the course after getting 6.00 to 6.49 credit points, as the case may be, credits corresponding to that course shall be counted only once for the graduation requirements.

d) When a postgraduate student is allowed to repeat a course with 6.00 to 6.49 credit points, the revised credit points shall be mentioned if there is an improvement in the credit points, otherwise the original credit points shall stand. But in the official record of the student maintained in the Registrar's office, both the earlier and

the credit points obtained after repetition,improved or otherwise, shall be mentioned and the fact that he/she repeated the course shall be indicated by the letter 'r' written above the credit points which he/she obtained after such repetition. But till such time as the student repeats the course, the original credit points and credits shall be used to compute the overall credit point average.

If a postgraduate student repeating 6.00 to 6.49 credit points does not obtain an OCPA of 6.50, he/ she shall be allowed to repeat the course with 6.00 to 6.49 credit points in other course(s) to complete his/her degree requirement subject to provision of semester rule 7.2.

**7.6.4. Dropping a student or Extension of the period of Scholastic Probation**

(a) If a student other than that covered in sub-rule (b) who remained on scholastic probation during a semester, fails to achieve the minimum required OCPA at the end of that semester also, the Registrar shall bring it to the notice of the Dean who shall order whether the student is to be allowed to continue on scholastic probation for one more semester or whether he/she is to be dropped from the University. On receipt of the Dean's decision, the Registrar shall take action accordingly. A student thus dropped shall have the right to petition for re-admission.

(b) Those undergraduate students who fail to achieve the CPA of 4.00/10.00 either in the 1st or 2nd semester of their admission shall be dropped permanently from the university. Dropping notice shall be issued after the declaration of result of compartment examinations. The concerned Dean shall withhold the registration of such students.

(c) Those postgraduate students who fail to achieve CPA of 5.00/10.00 either in the 1st or 2nd semester of their admission shall be dropped permanently from the university. Dropping notice shall be issued after the declaration of result of compartment examinations. The concerned Dean shall withhold the registration of such students.

**Note:** A semester which is cancelled on any ground by the university shall not be taken into account for counting two semesters for the purpose of automatic dropping. Similarly, a semester for which a student is allowed to drop on valid ground or semester(s) for which he/ she is rusticated shall not be taken into account for counting two semesters for the purpose of automatic dropping. For both the eventualities, the next semester(s) for which he/she gets registered will be counted.

(d) If a postgraduate student obtains unsatisfactory grade in research for two semesters continuously, he/she shall be dropped. Such students dropped under rule 7.6.4(d) may, within seven working days of the passing of such order, petition to the Registrar, PAU for continuation provided he/she is not placed on conduct probation on account of indiscipline in and outside the University. The petition shall be considered by a committee constituted for this purpose and the decision of the committee shall be final. On the detection of a patent error of fact, the petition committee may review its decision.

**7.6.5 Petition for Re-admission – deleted.**

**7.6.6 Registration of Students Re-admitted under Rule 7.6.5 - deleted.**

**7.6.7 Dropping of a semester, discontinuation of study and re-admission**

**a) Dropping of a semester :** A student may drop the current semester for which he/she has registered, with the permission of the Dean concerned due to personal sickness (atleast for two weeks duration)/the female students who are on the family way/suffer miscarriage/undergo medical termination of pregnancy. The medical certificate from the Senior Medical Officer, Civil Hospital or Medical Superintendents of Hospitals recognized by the PAU or Senior Medical Officer of Punjab Agricultural University Hospital will be required. The permission to drop the semester must be obtained before the start of end-of-term examination. Such a student can register for the next semester with the permission of the Dean concerned.

**b) Discontinuation of study programme and re-admission :** Discontinuation of a study programme shall be allowed only for such Postgraduate students who have secured jobs and wantto join the post. Such students must have completed all the course work, minimum of 75 per cent of research credits and cleared the comprehensive examination in case of Ph.D. students.

Such a student may be re-admitted by the Dean, Postgraduate Studies if the student seeks re-admission and joins the programme in the following semester after the expiry of his/her two discontinued semester or earlier.

The approval of the Academic Council will be required if the period of this discontinuation exceeds 2 semesters but is not more than 6 semesters. In such cases, a Ph.D. student shall have to clear the comprehensive examination afresh even if he/she had cleared the examination earlier.

The request for re-admission for consideration of the competent authority should be submitted to the Dean at least 2 months before the commencement of the semester in which student intends to seek re-admission. All such students will be re-admitted against the additional seats.

The student who discontinues his study programme without the permission of the Dean, Postgraduate Studies, shall not be eligible for re-admission.

**7.7 Preliminary Examination and Language Requirements for Ph.D.**

Passing in a Preliminary Examination as given in Rule 6.2 shall be one of the graduation requirements for the Ph.D. degree.

Every candidate for the Ph.D. degree shall also be required to obtain from the Department of Agricultural Journalism, Languages and Culture of the University, a certificate of satisfactory reading knowledge of one foreign language German, French or Russian.

**7.8 Thesis Requirements for M.Sc. and Ph.D.**

**7.8.1** A postgraduate student shall submit to the Dean, Postgraduate Studies, through Major Advisor, the subject of his/her proposed thesis and its synopsis not later than the end of the 1st Semester of his/ her first academic year. The subject of the thesis shall, as far as possible, relate to the research needs of the State and the area of specialization of the Major Advisor and shall be approved by the Committee consisting of the following:

a) Student's Advisory Committee

b) Head of the Deptt. concerned

c) Dean of the College concerned

d) Dean, Postgraduate Studies

e) Director of Research

f) Director of Extension Education

**7.8.2** Thesis/dissertation may be submitted on any date during the semester. However, the draft of the thesis shall be submitted atleast 10 days before the actual submission of the final thesis/dissertation (means complete thesis/dissertation).

**7.8.3** The student shall be required to submit 5 copies of his/her thesis to the Head of the Department through his/her advisor. The Head of Department shall send a copy to the Dean, Post-graduate Studies. Immediately after approval of the thesis, the Dean shall send three copies of the thesis to the Head of Department (one for the Departmental Library, one for the Major Advisor and one for the student) and two copies to the University Librarian who would keep one copy under lock and key as permanent record of the University and the second copy for the use of readers.

**7.8.4** The thesis shall be evaluated in accordance with rule 6.3.

**7.8.5** Ph.D. students will write and submit two research papers on their research work in journals of repute before their final viva voce examination.

## 8. Other Requirements for Graduation

**8.1** Every student in the 1st year of degree course shall have to participate in any one of three programmes viz. National Cadet Corps (NCC); National Sports Organization (NSO); and National Service Scheme (NSS) in accordance with the rules prescribed by the Academic Council.

Provided, however, that the Vice Chancellor may grant exemption from these requirements on medical grounds. Application for such exemption shall be submitted to the Dean of the constituent college in case of NCC and to the Director of Students' Welfare in case of NSO scheme and NSS duly recommended by the Unit Commander (Part time NCC Officer)/Incharge NSO, Incharge NSS and supported by Medical Certificate signed by the University Medical Officer/CMO or Assistant Civil Surgeon.

The educational tours, NCC, NSS, NSO camps shall generally be arranged during inter semester break.

**8.2** Educational Tour : Only one educational tour shall be compulsory for all the students admitted to the undergraduate programmes at Ludhiana and every student, in order to qualify for the Bachelor's degree shall be required to obtain satisfactory grades for this requirement provided, however, that Dean concerned may allow the student not to undertake a particular tour on medical grounds or owing to the fact that a student was deputed by the University for attending pre-arranged NCC, NSS, NSO camps or the tournaments or coaching camps organised by the Association of Indian Universities and its subsidiary federation or by the Indian Olympic Association and its subsidiary federations. Applications for the purpose shall be submitted to the Dean concerned duly recommended by the head of the department concerned, advisors concerned and supported by medical certificates signed by the University Medical Officer or by the Director Students' Welfare (for NSS and NSO activates only). The students will, however, have to go on this particular tour subsequently at their own expenses and obtain 'S' grade. If the student obtains 'US' grade after having been on tour, he/she will be given another chance to appear in the make-up test and earn 'S' grade.

## 9. Role of Head of Department and Registrar

**9.1** The Head of the Department concerned will ensure that each instructor actually completes the entire courses that he/she has to teach during a semester and will send a report to the Dean, that he/she has satisfied himself/herself about it.

**9.2** To ensure that requirements for the award of a degree have been completed by a student, the Registrar will keep a record of the courses completed by students.

## 10. Unfair Means in Semester Examinations

**10.1** The Dean of the College in which the student is registered shall be responsible for dealing with all cases of use of unfair means in the semester tests and examinations.

**10.2** The Instructor/Invigilator/Supervisor concerned shall report to the Dean through the Centre Superintendent/Head of Department concerned within two working days of the occurrence of each case of unfair means with full details of evidence and the explanation of the students, if any.

**10.3** The Dean shall take appropriate action and the penalty may be as indicated below:

a) Students in possession of copying material, mobile phone/blue tooth or found using unfair means during one hour test or mid-semester test will be debarred from the College/University for the unexpired portion of the semester and deemed to have failed in all the courses during the semester.

b) Students in possession of copying material, mobile phone/blue tooth or found using unfair means during the final semester examinations will be deemed to have failed in all courses taken by him/her in the relevant semester and placed on conduct probation for two subsequent semesters. However, if a student is found in possession of copying material, mobile phone/ blue tooth or found using unfair means for the second time, in any of the examination, he/she may be deemed to have failed in all courses taken by him/her in the relevant semester and also debarred from the College/University during the subsequent semester.

c) The mobile phone/blue tooth/any other device confiscated from the student in the Examination Hall will be kept in a cloth bag duly sealed by the Chairman of the College of Faculty Hearing and Disciplinary Committee for one year from the verdict of the College Faculty Hearing and Disciplinary Committee and thereafter it will be destroyed in the presence of the said committee under intimation to the Registrar.

**10.4 Impersonation in Examination**

a) The student who is impersonated shall be deemed to have failed in all the courses in the current semester; debarred from registration for next one semester; and placed on conduct probation for the subsequent two semesters.

b) If a person who impersonates a student in any examination during a semester is a student of any constituent college of the University (i) he/she shall be deemed to have failed in all the courses in the current semester; (ii) debarred from registration for the next semester; and (iii) placed on conduct probation for two subsequent semesters.

c) If the person who impersonates is not a student of any constituent college of the University, the case may be registered with the police.

d) If impersonation in the Entrance Test/Interview/Counselling is detected after the admission has been finalized, or after the candidate has registered for the programme, the admission of such candidate shall be cancelled forthwith and he/she shall be debarred from seeking admission to any programme of PAU for the two subsequent academic sessions, and the case may be registered with the local police.

e) In all cases of the use of unfair means/impersonation in the entrance test, the decision of Superintendent/ Assistant Coordinator/Coordinator/Controller of Examinations to expel or disqualify any candidate from the entrance test under the Admission Rules shall be final.

f) If any student of PAU impersonates in the entrance test conducted by the University action will be taken against him in the spirit of above rules.

**10.5** The aggrieved student may prefer appeal before the Vice Chancellor against the order of the Dean within two weeks from passing of such orders and decision of Vice Chancellor shall be final.

***Note :*** If a case of impersonation comes to notice during subsequent semester(s), necessary disciplinary action will be taken in the spirit of the above rule.

**11.** In all matters relating to admission and the operation of the semester system, the Registrar shall ordinarily act in accordance with recommendations of the Selection Committee or the Dean concerned.

Where, however, he does not agree with such recommendations/decisions, he shall refer thematter to the Vice Chancellor whose decision would be final.

## CONDUCT PROBATION

Any student involved in the violation of rules and regulations or act of indiscipline, may be placed onconduct probation of the following kind by the Dean:

placed on conduct probation with respect to academic activities.

or

debarred from the accommodation.

or

placed both on conduct probation for academic activities and debarred from hostel accommodation.

Such student shall not represent the College/University team and shall lose any office that he/ she may be holding in any student organization. If a student who is on conduct probation or who was on conduct probation on two previous occasions commits an act of indiscipline, he/she shall be dropped from the rolls of the College.

SECTION VII

# FACULTY OF AGRICULTURE

## General Information

## Disciplines

- Agricultural Extension Education
- Agricultural Meteorology
- Agronomy
- Animal Science Unit
- Entomology
- Food Technology (Processing Technology)
- Genetics and Plant Breeding
- Molecular Biology and Biotechnology
- Plant Pathology
- Soil Science
- Course curriculum for B.Sc. (Hons.) Agri. 4 year Programme
- Course curriculum for B.Sc. (Hons.) Agri 2+4 year Programme for first two years
- Course curriculum for B.Tech.(Food Technology) 4 year Programme
- Course curriculum for B.Tech. (Biotechnology) 4 year Programme
- Course curriculum for Diploma in Agriculture 2-year Programme
- Course curriculum for Diploma in Hybrid Seed Production Technology (Two semesters)

# COLLEGE OF AGRICULTURE

Agricultural education on scientific lines was started in India in the beginning of twentieth century. The Punjab Agricultural College and Research Institute, Lyallpur, was established in 1906 and admission to a 3-year diploma course was started in 1909. Teaching was in the local language *Urdu* and the diploma awarded was called Licentiate in Agriculture (L. Ag.) This college was affiliated to Panjab University, Lahore, in 1917 and the diploma course was replaced by a 4-year degree course leading to B.Sc. in Agriculture. Admission to the degree programme was based on merit and the seats were allocated to different commissionaries proportionate to the population. Subsequently the candidates were selected on merit according to the Communal Award.

During the first two years of 4-year degree programme, primarily courses on basic sciences and humanities were taught. However, agriculture with substantial emphasis on field practicals formed part of the instructions from first year of the degree programme. There was a university examination at the end of two years and a certificate was awarded to the successful candidates who passed as Fellows of Science in Agriculture (F.Sc. Agri.). Only those students who passed this examination were allowed to continue further studies for B.Sc. (Agri.) degree.

After independence in August 1947 a "Refugee College" was opened in November 1947 in a part of the building of Khalsa College, Amritsar, for the migrated students and the staff appointed by the East Punjab Government. Different persons acted as Officers-in-charge of the college. In the meantime, building of the Malwa Khalsa High School, Ludhiana, was rented by the Government to start the college as an independent institution. An advance team of four faculty members was sent to Ludhiana to take charge of the building. Dr Dalip Singh was appointed the first Principal of the college which opened at Ludhiana in September 1949 with 40 students.

One thousand and five hundred acres of evacuee land of Haibowal and the adjoining villages like Sunet, Rajpura, *etc.* near Ludhiana was allotted to the college by the Government for establishing a teaching and research institute at the present site of the Punjab Agricultural University. The foundation stone was laid by Sh Ajit Prasad Jain, Union Minister for Food and Agriculture, GOI on 23rd September 1955 and the college started functioning in the new building in September 1958.

The Government Agricultural College, Ludhiana was headed by various Principals, namely, Dr Dalip Singh (July 1949 to April 1952), Sh H. R. Saini (April to August 1952 and November 1952 to January 1953), Sh B. S. Sahney (August 1953 to July 1954), Dr M. R. Madhok (August to November 1952, January to August 1953 and August 1954 to October 1957), Dr S. S. Purewal (October 1957 to July 1960), Dr Kishan Singh Bedi (February to July 1960) and Dr Sardar Singh (November 1960 to June 1962). With the establishment of Punjab Agricultural University in 1962, the college was headed by the Deans of the Faculty of Agriculture, namely, Dr Gursham Singh (June 1962 to September 1966), Dr A. S. Atwal (September 1966 to November 1973 and, again, from October 1975 to July 1979), Dr Sukhdev Singh (November 1973 to February 1974), Dr N. S. Randhawa (February 1974 to October 1975), Dr K.S. Gill (August 1979 to February 1983), Dr G.S.Gill (February 1983 to May 1984), Dr D.S. Dev (September 1985 to September 1989), Dr K.S. Aulakh (September 1989 to May 1994), Dr M.S. Bajwa (August 1994 to June 1998), Dr P. S. Sidhu (June 1998 to March 2001), Dr M.S. Tiwana (June2001 to May 2005), Dr G. S. Chahal ( July 2005 to January 2008), Dr M. S. Aulakh (February 2008 to August 2010), Dr. D. S. Cheema (January 2011 to February 2013),Dr. H.S.Dhaliwal ( March 2013 to February 2017), Dr. S.S. Kukal ( May 2017 to August 2020) and presently by Dr. C.S. Aulakh who joined as Dean on November 6, 2023.

Before the establishment of PAU, the B.Sc. (Agri.) programme was organized on the old annual system of the Panjab University, Lahore/Solan/Chandigarh. Under the new regulations of the Panjab University, Chandigarh, introduced in 1961, two concurrent programmes were offered *viz*. 5-year programme after matriculation and 4-year programme after pre-university or higher secondary. The number of students admitted to the two programmes was 80 and 170, respectively. The aggregate marks obtained in four years out of maximum were shown on the transcript of B.Sc. (Agri.) graduate in order to indicate the consistency of the performance of the students.

After the establishment of PAU, a new educational system was introduced with the collaboration of Ohio State University, Columbus (USA). The trimester system of education with complete internal assessment was introduced for M.Sc. and Ph.D. programmes in 1963 and for B.Sc. (Agri.) programme in 1964. The students who were already enrolled in these programmes were allowed to continue their studies according to the previous regulations in vogue. The number of students admitted was increased to approximately 250 per year but subsequently in 1974, the admission capacity was stabilized around 170 per year. A separate programme for admitting 25 in-service Nepalese students was also started.

At the time of independence in 1947, some M.Sc. and one Ph.D. students who were earlier registered with the Punjab University, Lahore, continued their research for the fulfilment of their degree requirements as private candidates. The Panjab University, Chandigarh also framed rules for registering postgraduate students to complete their degrees based on thesis research. In 1961, new rules were framed which required such students to appear in three Theory papers and Practicals having a maximum of 400 marks, which they had to clear and the marks so obtained were added to the thesis marks which were awarded out of 300.

Under the ICAR programme of establishing centres of postgraduate education in the country, the College of Agriculture was also approved as one of such centres. Simultaneously, the regulations were modified by the Panjab University, Chandigarh and weightage to the thesis research was reduced. There were 450 maximum marks for Theory and Practicals, and 250 for thesis research. Another important feature introduced was the provision to admit regular students and the registered private candidates (only the teachers) were allowed to appear in the examinations and submit the thesis.

This system of education had just stabilized when the Formation of the Agricultural University Act was passed in October 1961. The previous system was continued for one year under the PAU, so that the already admitted students could complete their degrees. The new trimester system of education and the consequent rules and regulations became operative in July 1963 under the 'Statutes of the Punjab Agricultural University.' Regular admissions to M.Sc. and Ph.D. programmes in the existing departments of the College of Agriculture were made from August 1963.

In the Department of Agriculture, Punjab, the teaching and research was entrusted to various subject-matter Heads of Sections who were also designated as College Professors. With the establishment of PAU, these sections were upgraded as university departments and were headed by full professors. The Chronological establishment of the Departments in the College of Agriculture was as under:

- Department of Horticulture (1962) [Now Department of Fruit Science and shifted to College of Horticulture in 2019]
- Department of Agronomy (1963)
- Department of Animal Science (1963) [Shifted to GADVASU in 2006]
- Department of Entomology (1963)
- Department of Extension Education (1963)
- Department of Plant Breeding (1963) [Now Department of Plant Breeding and Genetics]
- Department of Plant Pathology (1963)
- Department of Soil Science (1963)
- Department of Food Science and Technology (1969)
- Department of Forestry (1978) [Now Department of Forestry & Natural Resources since 2007 and Shifted to College of Horticulture in 2019)
- Department of Seed Science and Technology (1991)
- Department of Agrometeorology (1981) later changed as School of Climate Change and Agricultural Meteorology (2012) and now named as Department of Climate Change and Agricultural Meteorology (2017)
- Department of Vegetable Crops, Landscaping and Floriculture (1974) [Split in Department of Vegetable Crops and Department of Floriculture and Landscaping in 1995 and now both the departments have been shifted to College of Horticulture in 2019]

- School of Agricultural Biotechnology (2008)
- School of Organic Farming (2017)

In May 1998, the Departments of Animal Science and Animal Nutrition were shifted to the College of Veterinary Science. The Department of Seed Science and Technology was upgraded to Directorate of Seed Science and Technology under Director of Research in July 1999. The Department of Agrometeorology was merged with the Agronomy Department and a new Department of Agronomy and Agrometeorology was created in March 2002. The Department of Home Science Extension Education of the College of Home Science was shifted to the College of Agriculture and merged with Department of Extension Education in November 2002. Later, the Department of Genetics and Biotechnology from the College of Basic Sciences and Humanities was shifted to the College of Agriculture and merged with Department of Plant Breeding and the new Department of Plant Breeding, Genetics and Biotechnology was created in September 2003. The Department of Forestry and Natural Resources was merged with Department of Agronomy & Agrometeorology and new Department of Agronomy, Agrometeorology and Forestry was created in June 2006. The Department of Business Management of the College of Basic Sciences and Humanities was shifted to the College of Agriculture in November, 2006. The Department of Foods & Nutrition of the College of Home Science and Department of Processing & Food Engineering of the College of Agricultural Engineering were shifted to the College of Agriculture and merged with Department of Food Science & Technology and new Department of Food Science & Engineering was created in December, 2006. The Departments of Vegetable Crops and Floriculture & Landscaping were merged and a new department named as Vegetable Crops, Floriculture and Landscaping was created in April, 2007. The merger of Departments was again dissolved in 2007 and all these Departments were demerged for efficient working.

Due to inherent complexities of switching over from one system to another, the transitional period from the conventional annual system of external examinations to the trimester system, with complete internal assessment, was inevitably a difficult one. In fact, the College of Agriculture was the first in India to successfully adopt the new system. With the hard work of faculty and the patience and cooperation of students, complete switch over to the new system was accomplished by the academic year 1968-69. The innovations in agricultural education and the rules and regulations framed to suit local conditions were accepted by the students. Most of these rules were subsequently adopted by other State Agricultural Universities in India.

By way of background, in 1963-64, the existing subjects as taught under the old annual system were hurriedly sub-divided into trimester courses for undergraduate and postgraduate programmes. Based on experience during the formative years, the course curriculum was rationally revised and operationalized in 1969. This revision was concurrent with the needs of the agricultural revolution which was already ushered in the state.

During seventies, agriculture in Punjab witnessed very rapid changes. The farmers became progressive and made heavy demands on agricultural education to meet the requirements of knowledge for intensive use of inputs, farm mechanization and diversification of agriculture. Hence the progressive agriculture in Punjab called for dynamic agricultural educational programme and the curricula. A critical revision of the various courses for B.Sc. (Agri.) programme was made which took almost one year. The new programme became operative in August 1973. The most significant feature of this programme was that the earlier concept of offering one major subject to the students in the final year, representing one of the thirteen departments, was changed and the disciplines were combined according to the professional specializations. The six new areas of elective subjects were: Crop Sciences; Animal Sciences; Soil Sciences; Plant Protection; Economics, Sociology and Extension Education; and Food Science, Technology and Nutrition. The new degree was renamed as B.Sc. (Agri.) with 'Honours' in one of these six specialized areas. The first batch students of B. Sc. (Agri.) Hons. were Graduated in 1963.

In 1974,"Earn While You Learn" schemes in the respective electives for the final year students were started. Revolving funds were created in various departments to meet the cost of inputs which was supplied to the students on loan from the common pool. When the produce was ready, they were encouraged to sell it in the market. The income from the saving of labour and innovative use of inputs was shared by the students. These activities included poultry farming, floriculture, food technology, nursery growing, dairy farming and vegetable growing. At present this scheme is operative only in Crop Production Courses (CPC) under the Department of Agronomy.

The fourth revision of the course curricula for B.Sc. (Hons.) Agri. was made in 1982 by maintaining the essential features of the degree programme and incorporating the recommendations of the second Deans' Committee of the ICAR and the National Commission on Agriculture.

Consequent upon the decision of the university to switch over from the trimester to semester system of education from the academic session 1988-89, the course curricula for undergraduate and postgraduate programmes were revised, updated and reoriented. The Practical component of the curricula was considerably strengthened. The minimum qualification for admission to B.Sc. (Hons.) Agri. was raised to 10+2 with science group (medical or non-medical streams) and later on the agriculture stream was also included. The revised curricula in the light of the recommendations of third Deans' Committee of ICAR and the syllabi for National Eligibility Test conducted by ASRB (for PG Programmes) had been implemented with effect from academic session 1998-99. The recommendations of fourth Deans' Committee were implemented for all UG programmes with effect from academic session 2009-10. At present, the recommendations of fifth Deans' Committee have been implemented for all UG programmes with effect from academic session 2016-17. The salient features of B.Sc. (Hons.) Agri. programme are:

- The component of basic sciences has been strengthened and new courses in the fields of Agri-business Management, Agrochemicals and Plant Products, Genetics, Biotechnology, Economics, Crop Physiology and Economic Zoology have been introduced.
- The Plant Clinic component which is a unique feature of the course curricula of this College, has been updated to provide hand's-on experience to the students in the diagnosis and management of plant diseases, pests, nutrient deficiencies and phytotoxicities.
- More emphasis has been laid on modern information technology, computer applications, integrated pest management, environmental science and international trade. The physical facilities for imparting instructions effectively have been improved by equipping the classrooms with permanent fixtures of audio visual aids (Multimedia) during 2004.
- Smart class rooms have been developed for imparting effective lectures and quality education.
- Vocational training in specialized fields such as Apiculture, Sericulture, Fish Culture, Mushroom Production, etc. has been introduced so as to promote self-employment of agricultural graduates.
- The agricultural engineering component has been strengthened with increased emphasis on farm machinery and its maintenance, farm structures and irrigation engineering.
- Special emphasis has been laid on project planning and evaluation to train the students for working as consultants in private and public sector undertakings and organizations dealing with agribusiness enterprise.
- In the final year, Rural Agricultural Work Experience (RAWE) and Experiential Learning Programme (ELP) have been introduced to focus on understanding and solving Practical problems of agricultural production in rural settings and to get hands-on-experience and develop entrepreneurship skills among the students.

The revision of course curricula of M.Sc. and Ph.D. as per ICAR guidelines was implemented from the academic session 2004-05, which was again revised by National Core Group Chaired by Dr J. C. Katyal and implemented with effect from academic session 2010-11. At present, the revised course curricula for M.Sc and Ph.D programmes in light of BSMA recommendations have been implemented w.e.f. academic year 2023-24 to bring about uniformity in syllabus at national level.

One year degree programme in Bachelor of Education was started in 1977 for B.Sc. Agri.(Hons), B.Sc. (Home Science) and B.Tech. (Agri. Engg.) graduates of PAU. A two year Diploma in Dairy Technology was started in 1979 in order to provide technicians for the newly established Milk Chilling Centres and Milk Processing Plants in the state. This programme was discontinued in 1991 due to lack of employment opportunities. The one year certificate course for Agricultural Sub Inspectors was modified into a two year Diploma in Agriculture in 1983, with an option to the students to terminate studies at the end of one year certificate course or to complete the diploma course. With the establishment of an 'Institute of Agriculture' at Gurdaspur in 1993, this diploma course was shifted there. In 1985, four year B.Sc. (Forestry) programme was started but it was discontinued in 1987. One year Certificate Course in Pesticides and Fertilizers' was started in 1993. This was, however, discontinued in 1998 due to lack of employment opportunities for these students. Thereafter, the college started new Diploma programmes in Apiculture, Pest Management, Food Technology & Seed Production from the academic year 2005-06 which were discontinued from academic session 2007-08.

Apart from B.Sc. (Hons.) Agri. the college now offers M.Sc. and Ph.D. programmes in nine disciplines. Keeping in view the sustainability of agricultural production in Punjab, new programmes at undergraduate and postgraduate level were initiated as B Sc .(Hons.) Agri 2+4 year programme after Matric (2008- 09) wherein the students attend first two years of their degree programme at Institutes of Agriculture located at Bathinda and Gurdaspur; B.Tech (Biotechnology) 4-year programme; B Tech. (Food Technology) 4-year programme (both under self supporting system after 10+2 medical or non-medical streams); Two year Diploma Course in Agriculture at College of Agricuture, PAU campus, Ludhiana and Regional Research Station, Faridkot (2016-17); One year Diploma course in Hybrid Seed Production Technology (2013-14); PG programmes started were M.Sc. Biotechnology (2008-09) and Ph.D. Biotechnology (2009-10).

Realizing the tremendous potential of biotechnology in increasing agricultural productivity, the University established an independent 'School of Agricultural Biotechnology' on April 24, 2008. The School is equipped with basic infrastructural research facilities for carrying out research on various aspects of Agricultural Biotechnology. There are different laboratories for conducting research on genomics, genome editing, genetic transformation, plant tissue culture, molecular biology, molecular cytogenetics and fully functional Bioinformatics Centre. Recently a separate building named after World Food Prize Laureate, Gurdev Singh Khush Institute of Genetics, Plant Breeding & Biotechnology has been established to serve as a hub for advanced genomic research in crop plants. The School has collaborations with John Innes Centre, Norwich, UK.; IRRI, Philippines; University of Missouri, USA, University of Maryland, USA; University of Sydney, Australia; NBPGR, NIPB, NIPGR,New Delhi and NABI, Mohali.

School of Climate Change and Agricultural Meteorology was established in 2012 upgrading the Department of Agricultural Meteorology with the objectives to undertake focused research on developing suitable technologies for sustaining natural resources and agricultural productivity under changing climate scenario and to impart quality education to undergraduate and postgraduate students on different aspects of agricultural meteorology. Scientists from allied disciplines of Agronomy, Soil Science, Entomology, Plant Pathology and Soil and Water Engineering have been associated to conduct the research work in field of climate change. Nevertheless, the school was again renamed as Department of Climate Change and Agricultural Meteorology in 2017.

Punjab Agricultural University established with a grant from ICAR, a State-of-the-art facility named as Electron Microscopy & Nano-Science Laboratory (EMN Lab) in 2007 having Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Energy Dispersive X-ray Spectroscope (EDS), and Scanning Probe Microscope (SPM), Optical Upright Research Microscope, Ultracut Microtome and Cryo Attachment, and Ion Sputter Coater facilities. The latest high resolution imagingtools in the EMN Lab for imaging particles as small as 1 nanometer (1 billionth of a meter) would enable scientists to develop technologies relevant to agriculture and food systems. It also facilitates research in basic biological, biomedical, chemical and material sciences to support the future needs of precision agricultural research.

The Old Boys' Association (renamed as Alumni Association) of the College was reactivated in 1968 when the regular students offered to contribute Rs.2/- per trimester. Directory of the alumni who graduated in various years was prepared for circulation and republished in 1990. The Association also started a quarterly magazine of its own under the name of "AGALUMNUS" This Association has published many books and Laboratory Manuals for improving the quality of agricultural teaching. A book bank was started in the college out of funds contributed by students. The books are issued to students on loan basis for a semester.

The student advisement which formed an essential and desirable feature of the trimester system of education has been considerably strengthened under the semester system. The advisors devote considerable time advising the students about curricular, co-curricular, social and emotional problems and serve as guides, mentors, role models and 'guardians-on-the-campus' for their advisees. With wise counselling and guidance by the faculty accompanied by receptive and proactive policies of the college, the defaults of the students have been considerably reduced facilitating timely completion of their degrees. The College has established a centrally located Placement and Counselling Cell, to provide the students with an access to wide range of temporary and permanent jobs by organizing campus interviews or through building their competence to face interviews, personality development and coaching for various competitive examinations.

The students' interest are taken care of by providing them ample opportunities to exercise choice for courses in various fields of specialization. Within the confines of their limits, the autonomy of the teachers is

assured, which is so essential under the system of internal evaluation. In order to ensure full coverage of the course contents, lecture outlines and references to the books and other relevant literature are distributed to the students in the beginning of the semester. The lesson plans and lectures of undergraduate courses on multimedia have been introduced for teaching from academic session 2004-05. Every student admitted to Bachelor's degree (*w.e.f.* academic session 2012-13) course is required to participate in any one of the three fold programmes namely NCC, NSO and NSS for first four semesters of their studies which was earlier for two semesters. A compulsory education tour to different institutes of agricultural importance located in different parts of country is also an integral part of course curriculum for different undergraduate programmes. Students also visit different institutes and locations during advisory tours.

# AGRICULTURAL EXTENSION EDUCATION

## PROGRAMMES

**M.Sc. Agricultural Extension Education**
**Ph.D. Agricultural Extension Education**

### COURSE REQUIREMENTS

**M.Sc.**

| | |
|---|---|
| Field of Specialization | Communication and Adoption of Innovations, Farmers' Training and Education, Extension Administration. |
| Core Courses: | Ext.-501, Ext.-502, Ext.-503, Ext.-504, Ext.-505, Ext.-506, Ext.-507 |
| Minor Fields: | Any agricultural subject related to research, Economics, Sociology or any other depending upon the student's interest and research problem. |
| Supporting Courses: | Stat.502 and other courses from subject- matter fields (other than Major and Minor) relating to area of special interest and research problem. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505, PGS 507 |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

**Ph.D.**

| | |
|---|---|
| Field of Specialization | Communication and Adoption of Innovations, Farmers' Training andEducation, Extension Administration. |
| Required Courses: | Ext.-601, Ext.-602, Ext.-603 |
| Supporting Courses: | Stat.526 and other courses from subject- matter fields (other than Majorand Minor) relating to area of special interest and research problem. |
| Minor Fields: | Any agricultural related to research, Economics, Sociology or any other subject depending upon the student's interest and research problem. |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved bythe Dean, Postgraduate Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**Ext. 101 Agricultural Heritage** **1+0** **Sem. I**

Introduction of Indian agricultural heritage, status of farmers in society; advice by sages to kings on their duties towards farmers, soil management in ancient, medieval & pre-modern India and its relevance in modern day sustainable agriculture, heritage of crop & water management, plant growth and development & plant protection through vrikshayurveda and traditional knowledge. Heritage of medicinal plants and their relevance today, seed health in ancient & medieval history and its relevance to present day agriculture, description of Indian civilization and agriculture by travelers from China, Europe and United States, our journey in agriculture, green revolution and its impact and concerns, vision for the future.

**Ext. 201 Fundamentals of Agricultural Extension Education** **1+0** **Sem. I**

**(For students of B.Sc. (Hons.) Horticulture)**

Education - definition and types. Extension definition, scope, process, principles. Extension programme planning - meaning, process, principles and steps. Extension systems in India - extension efforts in pre- (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment) and post-independence era Project, Nilokheri Experiment). Various extension/ agricultural development programmes of ICAR and Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP). New trends in agricultural extension- privatization of extension, cyber extension/e-extension, market-led extension, farmer- led extension, expert systems. Rural development–concept and programmes.

Community development-concept, definition, principles and philosophy. Rural leadership - concept and definition, types of leaders in rural context. Programme Planning- concept, meaning and importance Extension administration– meaning, concept, principles, functions. Monitoring and evaluation of extension programmes. Transfer of technology – concept, models and capacity building of extension personnel. Extension teaching methods -, meaning, classification, individual, group and mass contact methods, ICT applications in TOT (new and social media), media mix strategies. Communication – definition, principles and functions, models and barriers. Agricultural journalism. Diffusion and adoption of innovation – concept, meaning, process and stages of adoption, adopter categories.

**Practical:** Acquaintance with university extension system. Group discussion exercise. Handling and use of audio-visual equipment - digital camera and LCD projector. Preparation and use of AV aids. Preparation of extension literature – leaflet, booklet, folder, pamphlet, news stories and success stories. Presentation skills and microteaching exercises. Visit to village to understand the problems of villagers/ farmers. Understanding PRA techniques and their application in village development planning. Study of organization and functioning of DRDA and other development departments at district level. Visit to NGOs and learning from their experience in rural development. Exposure to mass media - visit to community radio and television studio for understanding the process of programme production. Script writing, writing for print and electronic media, developing script for radio and television.

**Ext. 202 Fundamentals of Agricultural Extension Education and Rural Development** **1+1** **Sem. II**

Education- meaning, definition and types. Extension Education: meaning. definition, scope and process, objectives and principles of Extension Education. Extension programme planning - meaning, process, principles and steps. Extension systems in India - extension efforts in pre- independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment) and post-independenc era (Etawah Pilot Project, Nilokheri Experiment). Various extension/ agricultural development programmes of ICAR and Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP). New trends in agricultural extension- privatization of extension, cyber extension/e-extension, market-led extension, farmer- led extension, expert systems. Rural development–concept and programmes. Community development-concept, definition, principles and philosophy. Rural leadership - concept and definition, types of leaders in rural context. Programme Planning- concept, meaning and importance Extension administration–

meaning, concept, principles, functions. Monitoring and evaluation of extension programmes. Transfer of technology – concept, models and capacity building of extension personnel.

**Practical : T**o get acquainted with university extension system. Group discussion exercise. Handling and use of audio-visual equipment - digital camera and LCD projector. Preparation and use of AV aids. Preparation of extension literature – leaflet, booklet, folder, pamphlet, news stories and success stories. Presentation skills and microteaching exercises. Visit to a village to understand the problems of villagers/ farmers. Understanding PRA techniques and their application in village development planning. Study of organization and functioning of DRDA and other development departments at district level. Visit to NGOs and learning from their experience in rural development. Exposure to mass media.

**Ext. 302 Communication and Diffusion of Innovations 1+1 Sem. II**

Communication: meaning and definition; Principles and functions of communication. Models and barriers to communication. Agriculture journalism; Extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies. Diffusion and Adoption of Innovations – concept and meaning, process and stages of adoption, Innovation - Decision Process, Elements of diffusion, Adopter categories and their characteristics, Factors influencing adoption process; Capacity building of Extension personnel and farmers- meaning, definition, types of training, Training of farmers, farm women and rural youth - FTC and KVK.

**Practical:** Simulated exercises on communication; Identifying the Problems, Fixing the priorities and selecting the most important problem for preparation of a project. Developing a project based on identified problem in a selected village. Organization of Group discussion and Method demonstration. Visit to KVK / FTC. Planning and writing of scripts for Radio and Television. Audio Visual aids - meaning, importance and classification. Visit to community radio and television studio for understanding the process of programme production. Planning & preparation of visual aids - Charts, Posters, Over Head Projector (OHP) Transparencies, Power Point Slides. Planning and preparation of agricultural information material - Leaflet, Folder, Pamphlet, News Stories, Success Stories. Field diary and lab record; indexing, footnote and bibliographic procedures. Handling of Public Address Equipment (PAE) System, Still camera, Video Camera and Liquid Crystal Display (LCD) Projector. Development of schedules, Questionnaires and field visits for Data Collection.

**RAWE 401 General Orientation 0+1 Sem. I**

**Practical:** Orientation of students regarding RAWE programme- concept, importance, villages to be visited, activities to be conducted, pre requisites before going to the village, rapport building, conduct and behaviour, preparation and planning of various activities, documentation of work done, monitoring and evaluation system. Acquaintance with Different Extension Teaching Methods- individual, group and mass method, acquaintance with different audio-visual aids. Participatory Rural Appraisal (PRA) techniques- meaning, concept, importance and application. Crop residue management (CRM)- concept, importance, techniques, technologies and machinery, subsidies and custom hiring. Visit to farm machinery workshop, State Department of Agriculture and Farmers' Welfare office and field visit of a successful farmer. *Rabi* Crops-Varieties of different Rabi crops as recommended by PAU, agronomic practices and their package of practice. Soil and water sampling- importance, techniques and procedure. Soil health Card scheme. Kitchen garden-importance, PAU models, planning and lay out. Field visit of PAU kitchen garden models. Integrated Farming System (IFS)- importance, models, feasibility analysis. Field visit of an Integrated Farming System model at PAU. Subsidiary Enterprises- types, scope and importance, entrepreneurship development among farmers, farm women and rural youth. Visit to dairy farm, mushroom farm and PAU Apiary. Farm Production plan and Budgeting- concept, importance and methods. Horticultural crops- planning and lay out of orchards, production management, post-harvest management and value addition of horticultural crops. Visit to PAU orchard and vegetable farm. Agricultural schemes- concept and importance of different agricultural schemes of the state and central governments. Swachh Bharat Abhiyaan, Agri start-ups, Farmer Producer Organisations. Social evils- concept and types. Awareness on drugs, social show offs, caste discrimination, women-based discrimination, etc.

**RAWE 402 Village Attachment** **0+8** **Sem. I**

**Practical:** Orientation of farmers regarding the RAWE programme- concept and importance, building rapport through individual contact method. Socio-economic and psychological survey of the farmers and baseline data of the village through PRA techniques and survey method. Analysis of the situation and identification of problems: Study of the existing farm situation, farmer practices, cropping pattern, status of technologies like DSR and CRM, subsidiary enterprises of the farmers, Agro-ecosystem analysis at farmers' field, Status of horticultural crops and agroforestry at village and farm level. Documentation of the existing situation of the farmer's field in form of a lay out and report. Preparation of a feasible and profitable farm layout for the farmer. Motivating the farmers for the development of farm production plan and budgeting. Imparting knowledge to the farmers regarding different paddy straw management technologies and motivating them to adopt the most viable technologies especially its in-situ incorporation through video films prepared by PAU, Ludhiana and sharing of success stories of farmers who have already adopted the different paddy straw management technologies. Promotion of custom hiring of RCTs by rural youth. Group Discussion with the farmers regarding varieties of wheat and other *Rabi* crops as recommended by PAU and their promotion. Method Demonstration on procedure for collection of soil and water samples. Collection of soil and water samples from the farmers' field and submission to the PAU soil laboratory and conveying of results thereafter. Imparting information to the farmers regarding Soil Health Card Scheme. Group discussion and conduct of campaign thereafter on social evils with the school children. Group meetings with the school children and school faculty regarding various PAU academic courses and scope of agriculture as a subject. Group Discussion with the farmers regarding package and practice for the *Rabi* Crops: Seed treatment in wheat, Weed management in different *Rabi* crops, Nutrient deficiencies and their management, Integrated Nutrient Management for different *Rabi* crops. Lay out and planning of a kitchen garden/ integrated nutrition garden in the farmers' field/backyard through method demonstration. Group discussion with the farmers regarding Integrated Farming System, its importance and feasibility at farm level. Group discussion with the farmers, farm women and rural youth regarding subsidiary occupations (dairy, bee-keeping, mushroom, etc) as a source of additional income/self-employment among them, Motivating them for the entrepreneurship development. Method demonstration on lay out of an orchard, group discussion on planning, production management, post-harvest management and value addition of horticultural crops/ vegetable crops with the farmers. Method demonstration on value addition of fruits, vegetables and food grains. Group meeting for discussing the pre requisites to be considered while purchasing of chemicals, Safe handling of pesticides. Imparting knowledge to the farmers, farmwomen and rural youth regarding various agricultural schemes of the Central and State governments, Agri start-ups and Farmer Producer Organisations. Swachh Bharat Abhiyaan campaign with the residents of the village and school children. Planning and preparation of an exhibition on Resource Conservation Technologies, other agricultural technologies and allied enterprises. Conduct of a mass meeting in the village to summarize the RAWE programme, various activities conducted and thanks giving to the residents of the village.

**RAWE 403 KVK and Research Station Attachment** **0+5** **Sem. I**

**Practical:** Orientation of students with KVKs and Research Stations- concept, importance, scope, mandates, activities conducted, functioning, staff and budget. Visit of the KVK farm, subsidiary units, adopted villages and interaction with successful farmers. Adaptive Research Trials (ARTs)- concept, importance, procedure and outcome. Visit of Art fields. Front Line Demonstrations- concept, difference from ordinary demonstrations, procedure and conduct. Visit to different FLDs at farmers' field. On-Farm Trials (OFTs)- concept, procedure and conduct. Visit to different OFTs at farmers' field. Short Duration Training programmes- Preparation and planning, conduct and evaluation of training programmes on package and practice of seasonal crops, value addition and processing of fruits, vegetables and milk products. Survey- concept, surveillance of insect-pests and diseases of the major crops of the region through field visits. Vocational Training programmes and Entrepreneurship Development- major subsidiary enterprises- beekeeping, dairy, poultry, mushroom production, vegetables, flower & fruit cultivation and value addition, feasibility, conduct of vocational trainings and entrepreneurship development. Interaction and visit to successful farmers of different enterprises in the region. Exposure Visits- Visits to ICAR and other Central institutes/ organizations, local beekeeping units, poultry units, SHGs and FPOs. Field Days- concept, importance, planning and preparation of field days. Kisan Melas/ Farmers' Fair- concept,

planning, preparation, conduct and participation in Kisan Melas. Miscellaneous Programmes- Planning, preparation, conduct and participation in programmes like Attracting and Retaining of Youth in Agriculture (ARYA), National Innovation on Climate Resilient Agriculture (NICRA), Promotion of Agriculture Mechanization for in-situ management of crop residue in the state of Punjab, Nutri-Sensitive Agricultural, Resources and Innovation (NARI), Integrated Resistance Management of pests and Formation of FPOs at Nation Level etc. being run at the KVKs.

**RAWE 404 Plant Clinic** **0+2** **Sem. I**

**Practical:** Orientation of students with Plant clinic- concept and importance. Visit to PAU Plant Clinic. Nutrient deficiencies- Identification and management of nutrient deficiencies in fruit plants, vegetables & field crops. Visit to PAU crop fields, orchards and vegetable farms. Disease infestation in plants- Identification of disease symptoms and their management in fruit plants, vegetables & field crops. Visit to PAU crop fields, orchards and vegetable farms. Insect-pest infestation- Identification of insect-pests, symptoms and their management in fruit plants, vegetables & field crops. Visit to PAU crop fields, orchards and vegetable farms. Weed infestation in plants- Identification of weeds and their management in crops. Visit to PAU crop fields and vegetable farms. Diseases and insect pest infestation in animals- Identification of disease symptoms, insect-pests of farm animals and their management. Visits to Crop Museum, Soil laboratories, Insect-pest Museum and dairy farm. Documentation of plant diseases, insect-pest infestation, nutrient deficiencies and animal insect-pests and diseases through live samples and photographs in the form of herbariums and scrap books.

## Postgraduate Courses

**Ext.-501 Extension Landscape** **2+0** **Sem. I**

**Unit I: Challenges before Extension and Advisory Services (EAS)**

Extension and Advisory Services (EAS)- Meaning (embracing pluralism and new functions) New Challenges before farmers and extension professionals: Natural Resource Management-Supporting farmers to manage the declining/deteriorating water and soil for farming. Gender Mainstreaming- How extension can enhance access to new knowledge among women farmers. Nutrition- Role of extension in supporting communities with growing nutritious crop and eating healthy food. Linking farmers to markets- Value chain extension including organizing farmers, strengthen value chain and supporting farmers to respond to new standards and regulations in agri-food systems. Adaptation to climate changes-How extension can contribute to up-scaling Climate Smart Agriculture. Supporting family farms strengthening the capacities of family farms. Migration-Advising farmers to better respond to opportunities that emerge from increasing mobility and also supporting migrants in enhancing their knowledge and skills. Attracting and Retaining Youth in Agriculture including promotion of agripreneurship and agri-tourism. Urban and peri-urban farming- How to support and address issues associated with urban and peri-urban agriculture. Farmer distress, suicides- Supporting farmers in tackling farm distress.

**Unit II: New Functions and New Capacities**

Beyond transfer of technology: Performing new functions to deal with new challenges. Organising producers into groups-dealing with problems that need collective decision making such as Natural Resource Management (NRM) and access to markets. Mediating conflicts and building consensus to strengthen collective decision making. Facilitating access to credit, inputs and services-including development of service providers. Influencing policies to promote new knowledge at a scale Networking and partnership development including convening multi-stakeholder platforms/ innovation platforms. New Capacities needed by extension and advisory services at different levels at the individual (lower, middle management and senior management levels), organizational and enabling environment levels; Core competencies at the individual level. Varied mechanisms for capacity development (beyond training).

**Unit III: Pluralism in EAS**

Pluralism in Extension Delivery: Role of private sector (input firms, agri-business companies, consultant firms and individual consultants)- Trends in the development of private extension and advisory services in India and other countries; challenges faced by private extension providers; Role of Non-Governmental

Organizations (National/International)/Civil Society Organizations (CSOs) in providing extension Experiences from India and other countries. Producer Organizations- Role in strengthening demand and supply of extension services; their strength and weaknesses-experiences from different sectors. Role of Media and ICT advisory service providers; global experiences with use of media and ICTs in advisory services provision.

**Unit IV: From the Linear Paradigm to Systems Paradigm**

Diffusion of Innovations paradigm - strengths and limitations. Multiple sources of innovation-farmer innovation, institutional innovation. Farmer participation in technology generation and promotion strength and limitations. Agricultural Knowledge and Information Systems (AKIS) - strength and limitations. Agricultural Innovation Systems (AIS). Redefining Innovation - Role of Extension and Advisory Services in AIS-From information delivery to intermediation across multiple nodes. Role of brokering. Innovation Platforms, Innovation Management. Strength and weaknesses of AIS. Rethinking Communication in the Innovation Process – Network building, support social learning, dealing with dynamics of power and conflict.

**Unit V: Evolving Extension Approaches**

Evolution and features of extension approaches: Transfer of technology approach, educational approach, farmer participatory extension approach, demand-driven extension, market led extension (value chain extension), extension for climate smart agriculture, gender sensitive extension, extension for entrepreneurship. Extension systems in different regions: Asia-Pacific, Europe, Latin America, Australia, North America Networking for Strengthening EAS: GFRAS (Global Forum for Rural Advisory Services) and its regional networks.

**Unit VI: Changes in Governance, Funding and Delivery**

Reduction in public funding: Public withdrawal from extension provision (partial/ full); Examples/ Cases; Privatization: Public funding and private delivery; cost sharing and cost recovery; Examples/ Cases; Decentralisation of extension services; Examples/ Cases; Lessons from extension reforms in different countries; Extension and Sustainable Development Goals (SDGs).

**Unit VII: Challenges in Managing Pluralistic Extension Systems**

Pluralism: Managing pluralism and Co-ordination of pluralistic extension provision; Public private partnerships in extension (including the role of local governments/ panchayats and producer organizations; Examples, challenges in co-ordination; Achieving convergence in extension planning and delivery, Financing Extension: Mobilising resources for extension: public investments, donor support (grants/loans); Monitoring and Evaluation of Extension: Generating appropriate data for Assessment and Evaluation of pluralistic extension; Strengthening extension policy interface; generating evidence on impact of extension and policy relevant communication.

**Ext.-502 Applied Behaviour Change** **2+1** **Sem. II**

**Unit I: Foundations of Human Behaviour**

Human behaviour – Meaning, importance and factors influencing human behaviour; Biological bases of human behaviour – Nervous system, brain, endocrine system and genes; Individual variations– intelligence, ability and creativity– foundations and theories, personality and temperament - foundations, approaches, theories of personality, measuring personality (traits, locus of control, self- efficacy; Personal, social and moral development – meaning, concepts – self-concept, self-esteem and self-worth and theories. Motivation – foundations, approaches, theories, managing human needs and motivations; perceiving others – impression, attitude, opinions; Emotions - foundations,types and functions, measuring emotional intelligence.

**Unit II: Cognitive Processes affecting Human Behaviour**

Sensory organs and their role cognition; Cognitive processes – Attention, perception, remembering and forgetting, knowledge and expertise – foundations and theories; Principles and processes of perception; Consciousness – meaning, types, sleep and dreams; Learning and Memory – Memory -meaning, types

and mechanisms of storage and retrieval of memories in the Human brain; Complexcognitive processes- Concept formation, Thinking, Problem solving and transfer – foundations, theories and approaches.

**Unit III: Information Processing**

Information processing – meaning, principles; Models of information processing - Waugh and Norman model of primary and secondary memory; Atkinson and Shiffrin's stage model of memory; other models including blooms taxonomy and Sternberg's Information Processing Approach; Attention and perception – meaning, types, theories and models; Consciousness.

**Unit IV: Learning**

Learning – foundations, approaches and theories; Cognitive approaches of learning – meaning, principles theories and models; Memory – foundations, types; Behavioural approaches of learning – foundations and theories - classical conditioning, operantconditioning, applied behaviour analysis; Social cognitive and constructivist approaches to learning – foundations and theories – social cognitive Theory, Selfregulated learning; learning styles – meaning, types and applications inlearning.

**Unit V: Judgement, Choice and Decision-making**

Human judgement – meaning, nature, randomness of situations, theories and models; Choice – meaning, criteria for evaluating options; theories and models of human choice; Choice architecture;Decision-making – Meaning, problem analysis; steps and techniques of decision-making under different contexts.

**Unit VI: Attitudes and Influence**

Attitudes - meaning, assumptions, types, theories and models of attitude formation; methods of changing attitudes, Relating to others - liking, attraction, helping behaviour, prejudice, discrimination and aggression; Liking / affect – meaning, types and theories; Attraction – meaning, types and theories; Persuasion – meaning, theories and techniques; Social influence and groups – conformity,compliance and obedience.

**Unit VII: Social Judgement, Social Identity and Inter-Group Relations**

Social judgement – meaning, frame of reference, stereotyping; The judgement of attitude models; Attribution – meaning, theories; Rational decision making; Social identify – meaning, types; assessment; Groups – meaning, types, group processes; sustainability of groups; Inter groupprocesses and theories social learning.

**Practical**

Understanding perception – Attentional Blink and Repetition Blindness exercise. Understanding attention - Testing selective attention capacity and skills and processing speed ability through Stroop test. Hands-on experience in the techniques for assessing creative thinking – divergent and convergent thinking • Lab exercise in applying Maslow's need hierarchy to assess motivation. Learning - Classical conditioning and operant conditioning. Assessing learning styles through Barsch and Kolb inventories. Practical experience in building self-esteem. Assessment of emotional intelligence. Exercises in problem solving. Exercises in visual perception. Measuring self-concept using psychometric tools. Experiment on factors influencing information processing. Assessment of attitudes. Hands on experience in methods of persuasion. Field experience in assessing social judgement. Simulation exercise to understand decision-making under different situations. Exercisein rational decision-making.

**Ext.-503 Organisational Behaviour and Development** **2+1** **Sem. II**

**Unit I: Basics of Organization**

Introduction to organizations-concept and characteristics of organizations; Typology of organizations; Theories of organizations: nature of organizational Theory, Classical theories, Modern management theories, System Theory - Criticisms and lessons learnt/ analysis.

**Unit II: Basics of Organizational Behaviour**

Concepts of Organisational Behaviour, Scope, Importance, Models of OB.

**Unit III: Individual Behaviour in Organizations**

Introduction, Self-awareness, Perception and Attribution, Learning, Systems approach to studying organization needs and motives – attitude, values and ethical behavior, Personality, Motivation- Concept & Theories, Managing motivation in organizations.

**Unit IV: Group Behaviour in Organization**

Foundations of group, group behaviour and group dynamics, Group Development and Cohesiveness, Group Performance and Decision Making, Intergroup Relations; Teams in Organizations-Team building experiential exercises, Interpersonal Communication and Group; Leadership: Meaning, types, Theories and Perspectives on Effective Leadership, Power and Influence, managing Conflict and Negotiation skills, Job/ stress management, decision-making, problem-solving techniques.

**Unit V: Productive Behaviour and Occupational Stress**

Productive behaviour - Meaning, dimension; Job analysis and Job performance –meaning, dimensions, determinants and measurement; Job satisfaction and organizational commitment - meaning, dimensions and measures roles and role clarity; Occupational stress – meaning, sources, theories and models, effects, coping mechanism, effects and management; Occupational stress in farming, farmer groups/ organizations, research and extension organizations.

**Unit VI: Organizational System**

Organizations Structure- Need and Types, Line & staff, functional, committee, project structure organizations, centralization & decentralization, Different stages of growth and designing the organizational structure; Organizational Design Parameters of Organizational Design, Organization and Environment, Organizational Strategy, Organization and Technology, Power and Conflicts in Organizations, Organizational Decision-Making; Organizational Culture vs Climate; Organizational Change; Organizational Learning and Transformation.

**Unit VII: Overview of Organizational Development**

Concept of OD, Importance and Characteristics, Objectives of OD, History and Evolution of OD, Implications of OD Values.

**Unit VIII: Managing the Organizational Development Process**

Basic Component of OD Program-Diagnosis-contracting and diagnosing the problem, Diagnostic models, open systems, individual level group level and organizational level diagnosis; Action- collection and analysis for diagnostic information, feeding back the diagnosed information and interventions; Program Management- entering OD relationship, contracting, diagnosis, feedback, planned change, intervention, evaluation.

**Unit IX: Organizational Development Interventions**

Meaning, Importance, Characteristics of Organization development Interventions, Classificationof OD Interventions-Interpersonal interventions, Team Interventions, Structural Interventions, Comprehensive Interventions.

**Unit X: Organizational Development Practitioner or Consultant**

Who is OD consultant? Types of OD consultants and their advantages, qualifications, Comparison of traditional consultants Vs. OD consultants, Organizational Development process by the practitionersskills and activities.

**Practical**

Case Analysis of organization in terms of process – attitudes and values, motivation, leadership. Simulation exercises on problem-solving – study of organizational climate in different organizations. Study of organizational structure of development departments, study of departmentalization, span of control, delegation of authority, decision-making patterns. Study of individual and group behaviour at work in an organization. Conflicts and their management in an organization. Comparative study of functional

and nonfunctional organizations and drawing factors for organizational effectiveness. Exercise on OD interventions (Interpersonal, Team, Structural, Comprehensive) with its procedure to conduct in an organization.

**Ext.-504 Research Methodology in Extension** **2+1** **Sem. I**

**Unit I: Nature of Behavioural Research**

Methods of knowing; Science and scientific method; Behavioural research – Concept, aim, goals and objectives; Characteristics and Paradigms of research; Types of behavioural research based on applications, objectives and inquiry; Types of knowledge generated through research – historical, axiological, theoretical and conceptual knowledge, prior research studies, reviews and academic debate; Role of behavioural research in extension; Careers in behavioural research.

**Unit II: The Behavioural Research Process**

Basic steps in behavioural research – Formulating a Research Problem; Reviewing the Literature; Identifying the variables and hypotheses; Formulating research designs, methods and tools; Selecting sample; Collecting data; Analyzing and Interpreting the Data; Reporting and Evaluating Research; Skills needed to design and conduct research; Writing research proposals.

**Unit III: Formulating a Research Problem**

The research problem and research topic - definitions; Importance of formulating a research problem; Sources of research problems; Characteristics of a good research problem; Research problems in quantitative and qualitative research; Steps in formulating a research problem; Strategies for writing research problem statement; Research purpose statement; Research questions – Types, Criteria for selecting research questions, techniques for narrowing a problem into a research question; Objectives - Meaning, types and criteria for judging the objectives.

**Unit IV: Reviewing the Literature**

Review-meaning and importance; Types of literature review – Context, Historical, Integrative, methodological, self-study and theoretical; Literature review for quantitative and qualitative studies; Steps in conducting literature review – Identify key terms, locate literature, critical evaluation and selection; organising literature and writing literature review.

**Unit V: Identifying Variables and Hypotheses**

Developing theoretical, conceptual, empirical frameworks; Approaches for identifying concepts, constructs and variables; Role of Theory in behavioural research; Steps in identifying variables – Domain, Concepts, Constructs, Dimensions; Indicators; Variables, Definitions, premises, propositions and hypotheses; Techniques of identifying concepts, constructs and variables - Types of concepts; Types of variables –causal relationship, the study design; and the unit of measurement; Types of definitions- Types of propositions and hypotheses. Characteristics of good hypotheses; Measurement – Meaning, levels of measurement – nominal, ordinal, interval and ratio; Criteria for choosing measurement levels for variables.

**Unit VI: Formulating Research Designs, Methods and Tools**

Research designs – Definition, purpose and functions; Research Design as Variance Control - MAXMINCON Principle; Criteria for selecting a suitable Research Design; Classification of research designs: Quantitative designs - experimental, descriptive, comparative, correlational, survey, ex- post facto and secondary data analysis; Qualitative designs - ethnographic, grounded Theory, phenomenological and Narrative research; Mixed method designs – Action research design; Translational research; Elements of research design - Research strategies, Extent of researcher interference, Study setting, Unit of analysis and Time horizon. Sources of errors while specifying research designs. Internal and external validity; Choosing right research design; Triangulation - Importance in behavioural research, Types of triangulation. Research methods: Designing research Instruments – questionnaires, interview schedules; tests – knowledge tests, behaviour performance tests; scales – scales and indexes, checklists, focus groups; Steps in developing and using research methods and tools; participatory rural appraisal.

**Unit VII: Selecting Sample**

Sampling - population, element, sample, sampling unit, and subject; Sampling strategies for quantitative and qualitative research; Principles of sampling; Factors affecting the inferences drawn from a sample; Types of sampling, Methods of drawing a random sample, Sampling with or without replacement, Types of sampling - Probability Sampling - Simple random sampling, Cluster sampling, Systematic sampling, Stratified random sampling and Unequal probability Sampling; Nonprobability Sampling - Reliance of available subjects, Purposive or judgmental sampling, accidental sampling, expert sampling, Snowball sampling, and Quota sampling; Sample size requirements for quantitative and qualitative studies. Methods for estimating sample size; Generalisation – Importance, Types of generalisations.

**Unit VIII: Collecting Data**

The process of collecting data – Selection, training, supervision, and evaluation of field investigators; Online data collection; Errors and biases during data collection. Testing goodness of measures through item analysis - Reliability and validity; Types of validity – Content validity: Face and content validity, Criterion-related validity: concurrent and predictive validity, Construct validity: convergent, and discriminant validity, factorial validity, and nomological validity; Types of reliability – Test-Retest, Parallel forms, Inter-item consistency reliability, Split-half reliability. Factors affecting the validity and reliability of research instruments, Strategies for enhancing validity and reliability of measures. Validity and reliability in qualitative research.

**Unit IX: Analyzing and Interpreting the Data**

Data coding, exploration and editing; Methods of data processing in quantitative and qualitative studies; Quantitative data analysis - parametric and non-parametric statistical analyses; Parametric analysis. Descriptive and inferential statistics, Hypothesis testing - Type I and Type II errors. Concepts in hypothesis testing - Effect Size, á, â, and Power, P Value; Multivariate data analysis, regression, factor analysis, cluster analysis, logistic regression and structural equation modelling. Guidelines for choosing appropriate statistical analysis; Statistical packages for data analysis; Methods of interpreting data and drawing inferences - The Ladder of Inference; Methods of communicating and displaying analysed data.

**Unit X: Reporting and Evaluating Research**

Writing reports and research publications; Evaluation Methodology

**Practical**

Selecting a research problem and writing problem statement. Narrowing down research problem to purpose, research questions and objectives. Choosing, evaluating and reviewing research literature. Selection of variables through construct conceptualisation and defining variables. Choosing research design based on research problem. Choosing right sampling method and estimating sample size. Developing research methods and tools – questionnaires, interview schedule, check lists and focus group guides. Writing a research proposal. Field data collection using research methods and tools. Testing reliability and validity of research instruments. Hands on experience in using SPSS for coding, data exploration, editing, analysis and interpretation Formulation of secondary tables based on objectives of research. Writing report, writing of thesis and research articles. Presentation of reports.

**Ext.-505 Capacity Development** **2+1** **Sem. I**

**Unit I: Capacity Development–An Overview**

Training, capacity building, capacity development and HRD-Meaning and differences; Need and principles of capacity development; Types and levels of capacities - Institutional capacities (include the rules, regulations and practices that set the overarching contextual environment), Organisational capacities (how various actors come together to perform given tasks), Individual capacities (technical, functional and leadership skills). Types of capacity building - Based on structure (structured, semi-structured &unstructured), Based on context (orientation, induction and refresher), and other categories (online, Webinar, distance etc.). Components of capacity development; Capacity development cycle.

**Unit II: Capacity Development- Approaches and Strategies**

Capacity Development Dilemma- Theory versus Practice, Trainee versus Task, Structured versus Unstructured, Generic and Specific; Approaches in Capacity Development -Informative approach, Participatory approach, Experimental approach/Experiential, Performance based approach; Capacity Development Strategies - Academic strategy, Laboratory strategy, Activity strategy, Action strategy, Personal development strategy, Organizational development strategy.

**Unit III: Planning and Organization of Capacity Development Programmes**

Steps in Designing and Planning of Capacity Development- Step 1. Select the participants, Step 2. Determine the participants' needs, Step 3. Formulate goal and objectives, Step 4. Outline the content, Step 5. Develop instructional activities, Step 6. Prepare the design, Step 7. Prepare evaluation form, Step 8. Determine follow-up activities; Organising capacity development programme; Operational arrangements at different stages- Before the programme, During the programme, Middle of the programme, At the end of the programme, After the programme, Follow up; Stakeholders' responsibilities.

**Unit IV: Planning and Organization of Capacity Development Programmes**

Concept of Need Assessment; Approaches in Need Analysis- Performance Analysis, Task Analysis, Competency Study; Needs Survey.

**Unit V: Capacity Development Needs Assessment Methods**

Data Collection Methods in Identifying Needs - Rational Methods (Observation, Informal talks, Complaints, Comparison, Analysis of report, Opinion poll, Buzz session, Analysis of the new programme), Empirical Methods (Job analysis, Performance evaluation, Checklist or Questionnaire Method, Tests, Critical Incident Technique, Card Sort Method, Focus Group Discussion, Interview, SWOT Analysis); Information and Skills required in Need Analysis; Identification of Needs through Task Analysis - Task identification, Task Analysis, Gap Analysis.

**Unit VI: Capacity Development Institutions**

Capacity Developer (Trainer): Meaning and concept; Types of Capacity Developers (regular, *ad- hoc*, part time, guest and consultants); Roles of Capacity Developer (explainer, clarifier, supporter, confronter, role model, linker, motivator, translator/ interpreter, change agent); Good Capacity Developer – Qualities, skills and roles Qualities, Skills (Intrapersonal & Inter personal), Roles(Manager, Strategist, Task Analyst, Media Specialist, Instructional Writer, Marketer, Facilitator, Instructor, Counsellor, Transfer Agent, Evaluator); Capacity Development Centres and Locations; Organisation's Role in Capacity Development.

**Unit VII: Capacity Development Project Formulation**

**Project Proposal**

Concept and Meaning; Steps in Project Formulation- Review of past proposals, Consulting experts, consultants, and previous organizers, Review past project evaluation reports, Interact with the prospective beneficiaries; Format for Writing Project Proposal (LFA).

**Unit VIII: Capacity Development Methods and Tools**

Capacity Development Methods –Lecture, Discussion, Syndicate, Seminars, Conference, Symposium, Role Play, Case study, Programmed Instruction, T - group/Laboratory methods; Factors Determining Selection of Methods – Capacity development objectives, subject matter, categories of participants, and the available resources like time, location, budget; Capacity Development Aids.

**Unit IX: Evaluation**

Capacity Development Programme Evaluation - Meaning & Importance; Purpose of Evaluation; Principles of Evaluation; Types of Evaluation – Formative, Summative, Kirkpatrick's four levels of evaluation; Process of Evaluation- Evaluation at the beginning, Evaluation during the programme, Evaluation at the end; Use of evaluation findings; Statistical Tools for evaluation.

**Unit X: Impact Assessment**

Impact Assessment- Meaning, Need, Features, Benefits, Concepts; Indicators for Impact Assessment - Direct indicators, Indirect or proxy indicators, Quantitative indicators, Qualitative indicators, Result chain / hierarchy of indicators; Methods of Impact Evaluation- Learning retention of participants (KOSA), Impact on the job performance, Impact on organizational effectiveness, Impact on stakeholder's competency.

**Unit XI: Human Resource Development**

HRD: Meaning, Importance and Benefits; Types of HRD Systems & Sub-systems Career system (Manpower planning, Recruitment, Career planning, Succession planning, Retention), Work system (Role analysis, Role efficacy, Performance plan, Performance feedback and guidance, Performance appraisal, Promotion, Job rotation, Reward), Development system (Induction, Training, Job enrichment, Self-learning mechanisms, Potential appraisal, Succession development, Counselling, Mentor system), Self-renewal system (Survey, Action research, Organisational development interventions), Culture system (Vision, mission and goals, Values, Communication, Get together and celebrations, Task force, Small groups); Components of HRD System - Performance Appraisal, Potential Appraisal, Task System, Development System, Socialisation System, Governance; Functionsof HRD-Organisational Development, Career Development, Capacity Development.

**Practical**

Capacity development needs assessment exercise. Capacity development project formulation exercise. Planning organizing and conducting an extension capacity development programme. Designing a programme. Writing learning objectives. Developing objectives into curriculum. Training plan. Organizing capacity development workshop. Evaluation with pre- and post-training tests. Training methods – Practicing each method mentioned in contents as group exercise.

**Ext.-506 ICTs for Agricultural Extension and Advisory Services 2+1 Sem. II**

**Unit I: ICTs- Concepts and Status**

ICTs- meaning, concepts, basics of ICTs, global and national status, types and functions of ICTs, innovations, meaning of e-Governance, e-learning, mLearning, advantages and limitations of ICTs.

**Unit II: ICTs in Knowledge Management**

Knowledge management-meaning, approaches and tools. Role of ICTs in Agricultural Knowledge Management.

**Unit III: e-Extension initiatives in Agriculture and allied sectors**

e-Extension, overview on Global and national e-extension initiatives, Inventory of e-Extension initiatives in Agriculture and allied sectors from Central and State governments, ICAR, SAUs, private sector and NGO initiatives in India.

**Unit IV: ICT Applications**

Knowledge centres (tele centres), digital kiosks, websites and web portals, community radio,farmers call centres, mobile phone based advisory services and mobile applications (mExtension, mLearning), Self-learning CDs on Package of practices, social media, digital videos, Market Intelligence and Information Systems- ICT enabled Supply-Chains and Value-Chains/ e-Marketing (e-NAM, Agmarknet, *etc*.).

**Unit V: ICT Expert Systems**

Expert System/ Decision Support System/ Management Information Systems, Farm Health Management & Intelligence System for Plant Health, Animal Health, Soil Health, Fishery, Water, Weather, etc.

**Unit VI: ICT Networks**

Global and regional knowledge networks, international information management systems, e-Learning platforms (MOOCS, Course CCRA, EduEx, *etc*), e-Governance Systems; digital networks among extension personnel, Farmer Producers Organisations (FPOs)/ SHGs/ Farmers Groups.

**Unit VII: Policies in Knowledge Management**

Global policy/ Standards on e-Governance, National policy on e-governance, Open Data/Open Gov Standards and Open Source etc; Language Technology Applications; National e-Agriculture policy/ Strategies/ guidelines.

**Unit VIII: Web Standards**

Web standards, creating and writing for webportals, development of mobile applications, developing digital videos- story board- video recording- video editing, types of blogs and writing guidelines.

**Unit IX: Social Media Applications to engage audience**

Video conference, live streaming and webinars, types and functions of social media applications, guidelines for preparing social media content, engaging audience and data-analytics.

**Unit X: Smart Technologies**

Open technology computing facilities, System for data analytics/ mining/ modelling/Development of Agricultural simulations; Remote Sensing, GIS, GPS, Information Utility (AIU); disruptive technologies-Analysis; Internet of Things (IoTs), Drones, Artificial intelligence (AI), block chain technology, socialmedia and Big Data analytics for extension.

**Unit XI: Human Computer Interactions**

Human Centered Learning/Ergonomics/ Human Computer Interactions-Meaning; Theories of multimedia learning - Sweller's cognitive load Theory, Mayer's cognitive Theory of multimedia learning, Schnotz's integrative model of text and picture comprehension, van Merriënboer's four- component instructional design model for multimedia learning; Basic Principles of Multimedia Learning - Split-attention, Modality, Redundancy, Coherence, Signaling, segmenting, pre-training, personalisation, voice embodiment; Advanced principles - Guided discovery, worked examples, Self- explanation, drawing, feedback, multiple representation, Learner control, animation, collaboration, prior knowledge, and working memory. Designing ICT gadgets based on human interaction principles Interactive design-Meaning, importance; Approaches of interactive design - user-centered design, activity centered design, systems design, and genius design; Methods of interactive design - Usabilitytesting methods.

**Practical**

Content and client engagement analysis. Designing extension content for ICTs. Creating and designing web portals, blogs, social media pages. Developing digital videos. Live streaming extension programmes and organising webinars. Working with Farmers call centres. Engaging with professional digital networks. Writing for digital media.

**Ext.-507 Evaluation and Impact Assessment** **2+1** **Sem. II**

**Unit I: Introduction to Evaluation**

Concept of Evaluation: Meaning and concept in different contexts; Why Evaluation is Done and When? Programme planning, analyse programme effectiveness, decision making, accountability, impact assessment, policy advocacy; Objectives, types, criteria and approaches of programme evaluation, evaluation principles; the context of program evaluation in agricultural extension; Role and Credibility of Evaluator: Role as educator, facilitator, consultant, interpreter, mediator and change agent. Competency and credibility of evaluator.

**Unit II: Evaluation Theories**

Evaluation Theory vs. practice – synergistic role between practice and Theory in evaluation; Evaluation theories - Three broad categories of theories that evaluators use in their works - programme Theory, social science Theory, and evaluation Theory (other theories/ approaches - Utilization-Focused Evaluation & Utilization-Focused Evaluation (U-FE) Checklist, Values Engaged Evaluation, Empowerment Evaluation, Theory-Driven Evaluation). Integration between Theory and practice of evaluation: –evaluation forums, workshops, conferences and apprenticeship/ internship.

**Unit III: How to Conduct Evaluation**

Ten Steps in programme evaluation: (1) Identify and describe programme you want to evaluate (2)Identify the phase of the programme (design, start-up, ongoing, wrap-up, follow-up) and type of evaluation study needed (needs assessment, baseline, formative, summative, follow-up) (3) Assess the feasibility of implementing an evaluation (4) Identify and consult key stakeholders (5) Identify approaches to data collection (quantitative, qualitative, mixed) (6) Select data collection techniques (survey interviews and questionnaires with different types) (7) Identify population and select sample (sampling for evaluation, sample size, errors, sampling techniques (8) Collect, analyse and interpret data (qualitative and quantitative evaluation data analysis) (9) Communicate findings (reporting plan, evaluation report types, reporting results, reporting tips, reporting negative findings (10) Apply and use findings (programme continuation/ discontinuation, improve on-going programme, plan future programmes and inform programme stakeholders).

**Unit IV: Evaluating the Evaluation**

Evaluating the Evaluation - 10 Steps as above with focus on conceptual clarity, representation of programme components and stakeholders, sensitivity, representativeness of needs, sample and data, technical adequacy, methods used for data collection and analysis, costs, recommendations and reports.

**Unit V: SWOT Analysis and Bar Charts**

SWOT Analysis – Concept, origin and evolution; SWOT As a Programme. Management Tool; Conducting SWOT. Analysis - Common Questions in SWOT. Analysis; Advantages and Disadvantages of SWOT; Bar Charts (Gantt Charts and Milestone Charts) - Characteristics, advantages and limitations.

**Unit VI: Networks**

Networks – Introduction, origin and widely used networks (Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM), differences between PERT and CPM, advantages and disadvantages. Networks Terminology – Activity, Dummy activity, Event (predecessor event, successor event, burst event, merge event, critical event), Earliest Start Time (EST), Latest Start Time (LST), Critical Path, Critical Activity, Optimistic time (To), Pessimistic time (Po), Most likely time (TM), Expected time (TE), Float or Slack, Event Slack, Lead time, Lag time, Fast tracking, Crashing critical path, Acclivity Table, Danglers, Normal Time. Rules for Preparation of Networks and Steps in Network Preparation with example.

**Unit VII: Bennett's Hierarchy of Evaluation**

Introduction to Bennett's hierarchy – Background and description; Relation between programme objectives & outcomes at 7 levels of Bennett's hierarchy – Inputs, activities, participation, reactions, KASA changes, practice and behaviour changes, end results. Advantages and Disadvantages of Bennett's hierarchy

**Unit VIII: Logic Framework Approach (LFA)**

Introduction to LFA – Background and description; Variations of LFA - Goal Oriented Project Planning (GOPP) or Objectives Oriented Project Planning (OOPP); LFA Four-by-Four Grid – Rows from bottom to top (Activities, Outputs, Purpose and Goal & Columns representing types of information about the events (Narrative description, Objectively Verifiable Indicators (OVIs) of these events taking place, Means of Verification (MoV) where information will be available on the OVIs, and Assumptions). Advantages and Disadvantages of LFA.

**Unit IX: Introduction to Impact Assessment**

Concept of Impact Assessment: Meaning, concept and purpose in different contexts; ImpactAssessment Framework: Meaning of inputs, outputs, outcomes, impacts and their relation with monitoring, evaluation and impact assessment.

**Unit X: Impact Assessment Indicators**

Indicators for impact assessment – meaning and concept; Selecting impact indicators; Types of impact indicators for technology and extension advisory services - social and behavioral indicators,socio-cultural

indicators, technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators.

**Unit XI: Approaches for Impact Assessment**

Impact assessment approaches – Quantitative, qualitative, participatory and mixed methods with their advantages and disadvantages; Quantitative Impact Assessment Types – Based on Time of Assessment (Ex-ante and ex-post), Based on Research Design (Experimental, quasi experimental, Non-experimental). Econometric Impact Assessment: - (Partial Budgeting Technique, Net Present Value, Benefit Cost Ratio, Internal Rate of Return, Adoption Quotient, *etc*). Qualitative and Participatory Impact Assessment Methods.

**Unit XII: Environment Impact Assessment (EIA)**

Concept of EIA – Introduction, What it is? Who does it? Why it is conducted? How it is done?; Benefits and important aspects of EIA-risk assessment, environmental management and post productmonitoring. Environmental Components of EIA – air, noise, water, biological, land; Composition of the expert committees and Steps in EIA process - screening, scoping, collection of baseline data, impact prediction, mitigation measures and EIA report, public hearing, decision making, monitoring and implementation of environmental management plan, assessment of alternatives, delineation of mitigation measures and EIA report; Salient Features of 2006 Amendment to EIA Notification - Environmental Clearance/Rejection, participants of EIA; Shortcomings of EIA and How to improve EIA process?

**Practical**

Search the literature using web / printed resources and identify evaluation indicators for the following: – Utilization-Focused Evaluation – Values Engaged Evaluation – Empowerment Evaluation

**Theory-** Driven Evaluation. Visit Directorate of Extension in your university and enquire about extension programmes being implemented / coordinated by Directorate. Develop an evaluation proposal of any one programme using 'Ten Steps in Programme Evaluation' discussed in the Theory class. Review any comprehensive programme evaluation report from published sources. Evaluate the report and write your observations following the 'Evaluating the Evaluation' approach. Identify at least four agriculture development programmes and their objectives being implemented in yourstate. Write two attributes each on Strengths, Weaknesses, Opportunities and Threats related to theidentified programme objectives in the SWOT grid. Identify an on-going development programme and make-out 6 activities from the programme. Draw a Gantt chart for 12 months programme activities. Write a report on evaluation hierarchy levels and indicators as per Bennett's hierarchy of evaluation for any development programme or project. Develop LFA four-by-four grid for any development programme or project with activities, outputs, purpose and goal and objectively verifiable indicators, means of verification & assumptions. Visit a nearby KVKs / ATIC. Select any agriculture technology with package of practices and extension advisory services promoted by KVK/ ATIC. Identify impact assessment indicators for social and behavioral indicators, socio-cultural indicators, technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators. Refer any Environment Impact Assessment report and analyse stepsin EIA. Write your observations.

**Ext.-508 Managing Extension Organizations** **2+1** **Sem. I**

**Unit I: Management- An Over view**

Management and Extension management – Meaning, concept, nature and importance; and theories of management. Management, administration and supervision - meaning, definition and scope; Approaches to management, Principles, functions and levels of management; Qualities and skills of a manager; Interpersonal relations in the organization; Reporting and budgeting.

**Unit II: Extension Management in public, private sector and other sectors**

Extension management (POSDCORB) in public sector, Department of Agriculture,Agricultural Technology Management Agency (ATMA), KrishiVigyan Kendra (KVK), SAUs, ICAR Institutes, Private sector, Cooperatives, NGOs, FPOs etc. Organisational Structure, Relations between different units-Challenges in management

**Unit III: Concepts in Management**

Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions; Human Resource Management: Manpowerplanning, Recruitment, Selection, Placement and Orientation, Training and Development; Dealing with fund and staff shortages in different extension organizations (KVK, ATMA etc.); Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles; Authority and responsibility, Delegation and decentralization, line and staff relations; Challenges of co-ordination in extension organizations; Managing interdepartmental coordination and convergence between KVK,ATMA and line departments; Coordinating pluralism in extension services; Challenges in managing public-private partnerships (PPPs) at different levels in agricultural development in general and extension in particular; Performance appraisal – Meaning, Concept, Methods.

**Unit IV: Motivation and Communication**

Managing work motivation – Concept, Motivation and Performance, Approaches to motivation, team building; Organizational Communication – Concept, Process, Types, Networks, Barriers to Communication; Mentoring, Time management, Team work and team-building strategies; Modernization of information handling

**Unit V: Supervision and Control**

Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision; Managerial Control – Nature, Process, Types, Techniques of Control, Observation, PERT and CPM, Management Information Systems (MIS): Concept, tools and techniques, MIS in extension organizations.

**Practical**

Simulated exercises on techniques of decision making. Study the structure and function of agro-enterprises, Designing organizational structure/ organograms. Group activity on leadership development skills. Simulated exercise to understand management processes. Field visit to extension organizations (ATARI, KVKs, NGOs), FPOs, dairy cooperatives to understand the functions of management. Practical exercises on PERT & CPM. Group exercise on development of short term and long-term plans for agro-enterprises. Developing model agriculture-based projects including feasibility study, financial planning and cost-benefit analysis.

**Ext.-509 Enabling Innovation** **1+1** **Sem. II**

**Unit I: Agricultural Innovation Systems: Concepts and Elements**

Origins of the innovation systems concept-Innovation vs Invention; Agricultural Innovation System (AIS) -ToT, FSR, AKIS and AIS compared, Key insights from AIS: How Innovation takes place; Role of different actors in AIS; Importance of interaction and knowledge flows among different actors, Role of Communication in Innovation Process; Role of Extension in AIS, Different views to analyze AIS: structural view, functional view, process view and capacity view.

**Unit II: Enabling Innovation**

Role of enabling environment: Policies and institutions in enabling innovation; Role of Government-Innovation Policy: Achieving coordination and policy coherence; Innovation Platforms; Role of Innovation Brokers, Methodologies for AIS Diagnosis: Typologies of existing methodologies-strengths and limitations; Assessing Extension and Advisory Services within AIS; Capacity Development in AIS: Strengthening capacities to innovate.

**Unit III: Scaling Up: Tools, Approaches and Pathways**

Scaling Up: Definitions; Changing views on scaling up: Approaches to Scaling Up: Push, pull, plant, probe: Scaling up pathways: Drivers and spaces for scaling up; Framework and Tools for Scaling up: Planning and implementing a scaling up pathways; Scalability assessment tools; Role of policies in scaling up: Influencing policies for scaling up; Innovation Management for scaling up knowledge and implications for Extension and Advisory Services.

**Practical**

Identify one crop/commodity sector and use AIS framework to diagnose actors and their roles, patterns of interaction, institutions determining interaction and the enabling policy environment and develop a AIS Diagnosis Report (Review and Key informant interviews). Undertake a case studyon a successful case of scaling up knowledge and identify factors that contributed to its success. Identify one specific knowledge (a technology, an approach) that has been recently introduced anddevelop an Up-scaling Strategy.

**Ext.-510 Gender Mainstreaming** **2+1** **Sem. II**

**Unit I: Historical Perspective of Gender**

Historical perspective of gender: Feminism and emergence of gender as a concept, Scope of gender studies in agriculture and rural development Social Sciences: Agricultural Extension Education

**Unit II: Agrarian Importance of Gender**

Agrarian Importance of Gender: Understanding the importance of gender in national and global agriculture-Key gender issues and challenges in agriculture - Gender and value chain- Global actionsto address gender-needs and strategies to address gender and women empowerment.

**Unit III: Gender Related Concepts and Divides**

Gender related concepts and divides: Understanding of the concepts of gender, gender equality and equity, gender balance, gender blindness, gender relations, gender neutrality, gender bias and discrimination, gender rights, gender roles and responsibilities. Gender budgeting, Gender divides and their implications such as gender digital divide, gender access to resources and inputs divide, gender mobility divide, gender wage divide, Gender needs: Practical and strategic.

**Unit IV: Gender Analysis**

Gender analysis: Importance, usage, prerequisites, techniques of gender analysis Tools for gender analysis.

**Unit V: Gender and Technology**

Gender and technology : How gender and technology impact each other, Gender neutral technology, Gender sensitive technology, Gender supportive assistance in technology adoption-Gender inagricultural research and extension.

**Unit VI: Gender Mainstreaming**

Gender mainstreaming: Importance of gender mainstreaming in agriculture, Extension strategies to address gender issues such as gender and health, nutrition, gender in agricultural value chains, gender and climate change adaptation, gender and globalization& liberalization for mainstreaming gender concerns into the national programmes and policies.

**Unit VII: Women Empowerment**

Women Empowerment: Importance of women empowerment, Current national women empowermentand gender indices. Women empowerment approaches (technological, organizational, political, financial, social, legal and psychological), Case studies based on experiences and learning from various development and rural development programmes.

**Unit VIII: Global Best Practices, Policies and Frameworks**

Global Best Practices, Policies and Frameworks: Global best practices, women empowerment and gender mainstreaming models and frameworks for addressing gender concerns in agriculture, approaches of various organizations: gender mainstreaming and special women focused programmes in agriculture and rural development.

**Unit IX: Entrepreneurship Development for Women**

Entrepreneurship development for women: Women entrepreneurship development in agricultureand agro processing: current status, women led enterprises, supporting organizations and schemes, Govt. policies, entrepreneurship development programme and process for women in agriculture.

**Practical**

Visit to a village for understanding rural gender roles and responsibilities as groups, followed byclass presentation by groups. Exercise for capturing shifts in gender roles and responsibilities Conducting gender analysis in a village using gender analysis techniques. Visit to agencies supporting women empowerment followed by report presentation. Each student to visit a differentorganization such as State Rural Livelihood Mission, Women Development Corporation, Department of Agriculture, Important NGOs working for women empowerment. Exercise for identification and prioritization of issues affecting/needs for women empowerment. Interaction with a successful women entrepreneur/ SHG.

**PGS-507 Basic concepts and techniques in Social Science Research 0+1 Sem. II**

**Practical**

Meaning, Definition, need and importance of social science research; Important concepts and terminologies in social science research; Development of conceptual framework; Secondary sources of data and their use in social science research; Types of data and their importance in social science research; Development of tools for different types of data; Survey Methodology; Interpretation of different types of data; Development of excel sheets for qualitative data in social science research; Basics of data analysis and visualization in social science research.

**Ext.-591 Seminar 1+0**

**Ext.-599 Master's Research 0+30**

## Ph.D. Courses

**Ext.-601 Policy Engagement and Extension Credit Hours 2+1 Sem. II**

**Unit I: Why Policies Matter?: Understanding Policy**

Why policies are important for extension? Role in providing structure, ensure funding and framework for providing functions-examples; Policy: definitions and types: Is policy a product or a process or both? Policies and institutions-How these influence defining organisational roles and performancein extension organizations Role of policies in upscaling knowledge-Role of extension in influencing policies to enable innovation.

**Unit II: Policy Advocacy and Tools**

Definition of advocacy, Approaches to policy advocacy-Advising, Media campaigning, Lobbying, Activism, Information Education Communication (IEC) and Behavior Change Communication (BCC); Advocacy for Rural Advisory Services (RAS); Policy advocacy strategy.

**Unit III: Policy Analysis**

Explain the meaning and use of policy analysis in decision- making; Describe different types of policy analysis- empirical, evaluative or normative policy analysis, retrospective/ prospective policy analysis, predictive/prescriptive/descriptive policy analysis; How to do policy analysis? - understand the process of policy analysis, highlight the different methods and techniques used in policy analysis, doing ethical policy analysis; Tools for policy impact- research tools, context assessment tools, communication tools, policy influence tools.

**Unit IV: Policy Development Process**

Policy development process: Who drives policy change?: National Governments, Donors, Civil Society-varied experiences: Understanding the environment and key actors in policy space- problem identification-policy adoption, implementation and evaluation; stakeholder mapping, identifying opportunities and barriers, mobilizing financial resources; Dealing with policy incoherence: identifying contradictions and challenges in policy implementation

**Unit V: Using Evidence to Influence Policy Change: Influencing Policy Change**

Generating evidence: Role of policy research; analyzing the usefulness and appropriateness of the evidence; Using evidence in policy advocacy; Understanding your audience: analyzing channels of influence; creating alliances; identifying policy champions; Defining goals and objectives; Developing advocacy messages: Policy papers, Policy briefs, good practice notes, *etc*.: Good practices ininfluencing policies Organising policy dialogues: Policy engagement strategy-Engaging with policy makers: GO and NGO experiences; Policy working groups; advisory panels; use of committees: Use of media including ICTs and social media for influencing policies.

**Unit VI: Global Experience with Extension Policy**

Extension policy in different countries: Explicit extension policy Vs extension as part of Agriculture Policy, Challenges in policy implementation: lack of capacities, financial resources, ownership, lackof stakeholder consultations: Strengthening capacities in extension to influence policies: Global Forum for Rural Advisory Services (GFRAS)'s efforts in strengthening extension policy advocacy: policy compendium, training modules, training for strengthening capacities to influence policies.

**Practical**

Analysis of country/state level agricultural/extension policy to understand the policy intentions from strengthening EAS. Analysis of extension policy of other countries: policy intentions, processesadopted in development of the policy and mechanisms of policy implementation. Interview key policy actors in EAS arena at the state/national level (eg: Director of Agriculture, Director of Extension in SAU, Chairman/ Managing Director of Commodity Board. Member Agriculture, State Planning Board) to explore policy level challenges in EAS. Identify what evidence policy makers look for from extension research? Is the evidence available? If so what form? (Reports, Briefs etc), If not, develop a plan. Explore how different stakeholders influence policies (eg: policy advocacy of prominent NGOs, private sector and public sector) -What mechanisms and tools they use. Identify policy level bottlenecks that constrain effective EAS delivery at the district level- Eg: Issues around linkages between KVK and ATMA; inter-departmental collaboration; public private partnerships; joint action etc.

**Ext.-602 Methodologies for Social and Behavioural Research 2+1 Sem. II**

**Unit I: Advanced Methods for Improving Quality of Research Data: Measurement Properties of Research Instruments**

Measurement properties – Dimensionality, reliability and validity; Dimensionality – Unidimensionality and multidimensionality, Methods of assessing dimensionality, Formative and reflective constructs; Validity - Importance, Internal validity - face validity; content validity, Substantive Validity, Structural Validity; External validity - Convergent and Discriminant Validity, known-group validity, Criterion- Related Validity, Consequential Validity, nomological validity; Methods of assessing various forms of validities – Judges rating, Lawshe's Content Validity Ratio, Item-objective congruence index; latent variable method; Reliability - Internal consistency reliability – Split-Half, Cronbach alpha; Temporal Stability reliability - test-retest method; Interrater Consistency and Consensus – inter rater reliability and interrater agreement; Alternative Forms or parallel forms reliability – Reliability of difference - Factors Affecting the Validity and Reliability of Test Scores; Generalizability Theory

**Unit II: Threats to Data Quality**

Errors and biases; Errors – Meaning and sources; Types - Sampling error, Nonsampling or measurement error and Processing error – Meaning, causes; Effects of errors and biases on data quality; Bias in behavioural research – Meaning, causes, Types – Respondent and researcher biases;Methods of reducing errors and biases in surveys, questionnaires, personal interviews, focus groups and online methods

**Unit III: Scales, Indexes and Tests: Scales, Indexes and Tests-1**

Approaches to measurement and scale development - Classical test Theory. Formative or index models, The C–OAR–SE approach and Item Response Theory; Item analysis in Classical test Theory item difficulty and item discrimination; Scoring performance in scales and tests – meaning, types and methods; Scale development strategies – deductive and empirical; Stimulus-centred scales method

of equally appearing intervals, paired comparison, Person scaling – Q methodology; Subject centre scales – The Likert scale and Semantic Differential

**Unit IV: Scales, Indexes and Tests-2**

Steps in constructing a multi-dimensional scale using confirmatory factor analysis, Response scales Guttman's scalogram analysis and The Rasch method; Indexes –Meaning, types, importance; Similarities and differences with scales, Methods of constructing indexes; Common indexes used in extension. Measurement invariance –Meaning, types, methods of assessing measurement invariance. Tests – meaning, types, importance; steps in conducting various tests – knowledge test

**Unit V: Emerging Research Approaches and Designs: Qualitative Research Methods**

Qualitative methods – Meaning; Types – Ethnography, Grounded Theory, Phenomenology, Ecological psychology, Discourse Analysis; Observational research; Case study research – Sampling and sample size; Data collection methods - Indepth interviews, Focus groups, Direct observation, Record review; Content analysis; Unobtrusive Measures; Projective and semi-projective techniques; Selecting right qualitative method – Strengths and limitations of qualitative research; Analysis and interpretation of qualitative research data; Research synthesis – meaning, importance, methods; Systematic reviews and meta-analysis – meaning, steps, and applications; Policy research

**Unit VI: Emerging Approaches**

Mixed methods research – meaning, purpose, types and applications; Participatory research Meaning, importance, types, methods and tools and applications; Action research – Meaning, importance, Principles, Types, Steps in conducting action research, application in behavioural sciences. Social Network Analysis – Meaning, importance, types, steps in social network analysis, applications; Advanced methods of measuring perception and beliefs. Multi criteria decision making, analytical hierarchy approach

**Unit VII: Utilising Research Outputs: Publishing Research**

Scholarly communication process; Research reports – Meaning, types, contents; Presentations Meaning, types, principles of good presentation - Tell 'Em" and KISS 'Em" principles; Research publications – meaning, importance, types; Guidelines for preparing research papers - Peer review process, citation styles; Open access publishing; Publishing in social media. Software in academic writing.

**Unit VIII: Ethics in Extension Research**

Ethics in conducting behavioural research; Human subject research – Meaning, history, and ethical guidelines; Ethical aspects of collecting and using Indigenous knowledge and farmers technologies; Ethical practices in publishing; Plagiarism – meaning, sources, Identifying and correcting plagiarism in a research paper using anti-plagiarism software

**Practical**

Practice in developing research instruments. Methods of assessing measurement properties of research instruments - dimensionality, reliability and validity. Hands-on exercise in minimising errors and biases. Hands-on experience in constructing tests, scale and indexes. Practice in summated scale development using confirmatory factor analysis. Hands on experience in assessing measurement invariance. Practicing and collecting data using participatory tools and techniques, analyzing and interpreting qualitative data. Hands-on experience in writing systematic review using meta-analysis. Field practice in conducting action research. Practical experience in writing research paper. Hands on exercises using software for qualitative data analysis. Practice in detecting and correcting plagiarism using software.

**Ext.- 603 Technology Commercialisation and Incubation 2+1 Sem. I**

**Unit I: Technology Commercialisation and the Modern Context: Basics of technology commercialization**

Technology - Definition, functions, process of technological advancement – invention, discovery, innovation and technology; types of innovation - Basic research, Breakthrough innovation, Disruptive Innovation and Sustaining Innovation; Technology transfer and commercialization

**Unit II: Nature of Agricultural Technology**

Agricultural technology – meaning, types; technology generation system; technology life cycle

**Unit III: Basics of Technology transfer and commercialization**

Technology transfer Vs Commercialisation; Technology Commercialisation process – elements, models, systems and processes; Technology transfer model – research, disclosure, development and commercialization

**Unit IV: Intellectual Property Resources (IPR) Management: Overview of Intellectual Property Resources**

Introduction to IPR; Overview & Importance; Genesis; IPR in India and IPR abroad; Patents, copyrights, trademarks & trade secrets, geographical indication, industrial design; Emergence of IPR Regimes and Governance Frameworks - Trade-Related Aspects of Intellectual Property Rights (TRIPS), Convention on Biological Diversity (CBD), Cartagena Protocol, International Union for Protection of New Plant Varieties (UPOV), and BIMSTEC.

**Unit V: Systems for Protecting IP**

IPR protection laws and systems – National IPR Policy; and IPR laws; procedures for filing IP protection; Systems of IP protection and management in agricultural universities and research institutions and also by stakeholders.

**Unit VI: Management of IPR**

Mechanisms of IPR Management – Institutional arrangement, IP Management processes – invention disclosure; IP portfolio management; Infringement management

**Unit VII: Protection and Management of Biological Resources**

Introduction; National Biodiversity Act (2002); Protection of Plant Varieties and Farmers Rights Act (2001); Guidelines for registration and transfer of biological resources; Farmers rights; Mechanisms of documenting/ collecting, protecting and commercializing farmers varieties and other biological resources; National Biodiversity Authority, PPVFRA and other agencies involved in management of biological resources in India. Access to Genetic Resources and Sharing of Benefits

**Unit VIII: Protection, Management and Commercialisation of Grassroot and Farmers Innovations, Traditional and Indigenous Knowledge**

Traditional and Indigenous Knowledge, Grassroot and Farmers Innovations – Meaning, forms and importance; Systems of documentation, registration, protection and commercialisation. Documentation of traditional indigenous knowledge - Traditional Knowledge Digital Library (TKDL), Community Biodiversity Registers(CBRs), People's Biodiversity Registers (PBRs), Plant Biodiversity Register, and Honeybee Network.

**Unit IX: Geographical Indications (GI) and Appellation of Origin**

Geographical indications and appellation of origin – meaning, origin; Geographical Indications of Goods (Registration and Protection) Act (1999); Documentation, registration and commercialisation of GI protected materials and processes.

**Unit X: Genetically Modified Organisms (GMO), Agriculture and Biosafety**

The Global Concerns on Use of Genetically Modified Organisms in Food and Agriculture; The Cartagena Protocol on Bio-safety; Regulation of GMO in India - Recombinant DNA Advisory Committee (RDAC), Institutional Bio-safety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC), State Bio-safety Coordination Committee (SBCC) and District Level Committee (DLC). Laws and Acts for regulation of GMO - Guidelines for Research in Transgenic Plants, 1998; Seed Policy, 2002; Plant Quarantine Order, 2003; Regulation for Import of GM Products Under Foreign Trade Policy, 2006; National Environment Policy, 2006

**Unit XI: Technology Commercialisation: Technology Assessment and Refinement**

Meaning; Importance; Approaches and methods of assessment and refinement of various technologies – stakeholder-oriented approaches including participatory technology assessment and refinement; assessment and refinement of traditional and indigenous knowledge and grassroot innovations.

**Unit XII: Technology Valuation**

Returns to investment; IP Valuation-Oxford context, IP Valuation methods - Cost approach; Income approach - Discounted Cash Flow, Risk-Adjusted Net Present Value, Net Present Value with MonteCarlo Simulation and Real Options Theory; Market approach - Industry Standards Method, Rating/ Ranking Method, Rules of Thumb Approach and Auction Method; Hybrid approaches; Royalty ratemethod.

**Unit XIII: Technology Commercialisation Strategies**

Meaning- approaches for technology commercialisation – technology scaling up, technology licensing, handholding, agripreneur development, technology business incubation.

**Unit XIV: Scaling up of Technologies**

Meaning, types and stages of technology scaling up; mechanisms.

**Unit XV: Technology Licensing**

Meaning and types - Procedures of licensing, preparing licensing documents; Management of technology licensing process.

**Unit XVI: Technology Takers and Entrepreneurship**

Meaning; types of technology takers; Technology Taking as a Strategy; Types of entrepreneurship agripreneurs, startups, small businesses, Producer Organizations, Self Help Groups, Clusters andother forms of entrepreneurship.

**Unit XVII: Policy support for Technology Commercialisation and Entrepreneurship Development**

Policy support for entrepreneurship development in India - National Policy on Skill Development and Entrepreneurship and other polices; Government of India Support for Innovation and Entrepreneurship – Startup India, Make in India, Digital India, Atal Innovation Mission and others; Entrepreneurship policy and schemes at different states of India; Organisations promoting entrepreneurship in India.

**Unit XVIII: Technology Incubation: Basics of Technology Incubation**

Meaning, functions and types; stakeholder-oriented incubation process – Livelihood incubation, village incubators.

**Unit XIX: Technology Incubation in India**

System of technology incubation- incubation process; its effectiveness; Managing profit oriented and non-profit incubators; Schemes for promoting incubators in India.

**Unit XX: Technology Promotion and Essential Skills For Technology**

Commercialisation: Technology Promotion Technology promotion – meaning, types, business meetings, scientist-industry/ entrepreneur meets, technology conclave, business plan competition, farmers fairs, technology shows.

**Unit XXI: Dealing with Entrepreneurs, Agripreneurs and Other Stakeholders**

Business communication; Business Etiquette; business networking.

**Unit XXII: Emerging Approaches in Technology Commercialisation and Incubation: Technology Scouting**

Technology Scouting and Innovations in technology incubation

**Practical**

Understanding the technology commercialisation process – Visit to Technology Commercialisation Unit of ICAR Institute/ Agricultural University. Understanding the IPR protection practices – Visit to Patent Attorney office. Hands-on experience in drafting IPR application – Patent/Copyright/ Trademark. Understanding protection of biological resources including plant varieties – Visit to PPVFRA Branch office/ ICAR Institute or Agricultural University involved in plant variety protection. Documenting Traditional and indigenous knowledge – Field experience in using various protocols of using traditional and indigenous knowledge. Protecting unique local goods through Geographical Indications – Hands on experiences in documenting and registering Geographical indications. Technology assessment/ validation of traditional and indigenous knowledge – QuIK and other methods. Hands on experience in technology valuation. Hands on experience in technology licensing process including drafting agreements. Understanding the Technology Business Incubation – Visit to Agri Business Incubator or Technology Business incubator. Hands on experience in planning and organising technology promotion events. Hands on experience in various techniques in business communication and Business etiquette.

**Ext.604 Educational Technology and Instructional Design 2+1 Sem. II**

**Unit I: Educational Technology: The Landscape of Educational Technology and Instructional Design**

Understanding various terms - educational technology, instructional design, instructional systems design, curriculum design, pedagogy, andragogy; Brief overview of the origin and evolution of ET and ID as Theory and practice; what is the relevance of ET and ID relevant in extension and rural advisory services? Extensional professionals as instructional designers and architects of the learning experience.

**Unit II: Theories of Learning**

What is learning? Critical overview of Behaviorism, Cognitivism, Constructivism and Complex learning theories*;* instructional designers and learning theories; Types of learning or learning domains- Bloom's taxonomy of the cognitive domain, Krathwohl and Bloom's affective domain and Simpson's psychomotor domain.

**Unit III: Technology Enabled Learning**

What is the role of technology in education? Digital media, new tools and technology; Open and distance Learning (ODL); Online Education - Synchronous and Asynchronous learning models; eLearning, Massive Open Online Courses -SWAYAM, Open Education Resources (OERs), Course CERA, EduEx, CoL, RLOs; digital education and its applications in higher agricultural education; Smart classrooms and Campuses, Web-based remote laboratory (WBRL); Integrating media and digital tools into ID; types and implications of disruptive technologies for higher education and extension;Augmented learning; Adaptive learning; meaning, features and good practices in using open source Learning Management Systems (Moodle); Quality assurance and certification in e-learning.

**Unit IV: Instructional Design: Theories and Models of Instruction**

Howard Gardner's Theory of Multiple Intelligences, David Kolb's Experiential Learning Cycle, Albert Bandura's Social Learning Theory, Rand Spiro's Cognitive Flexibility Theory and Its Application In eLearning, Wlodkowski's Motivational Framework for Culturally Responsive Adult Learning; ADDIE Model, Dick and Carey Model, SAM Model, Bloom's Taxonomy; integrating the theories of instruction into the practice of ID in extension and RAS ecosystem.

**Unit V: Creating Instruction**

Overview of planning, designing and implementing the curricula and learning experiences; Needs Analysis - meaning, approaches and steps; Task and content analysis - meaning, approaches, steps and techniques (topic analysis, procedural analysis, and the critical incident method); Learner analysis – meaning, importance and approaches, relevance of Maslow's Hierarchy of Needs and learning styles, Captive Audience vs. Willing Volunteers, Universal vs. user-centered design, LearnerAnalysis Procedures; Writing learning objectives: Meaning of Learning Goal and Learning Objectives; ABCDs of well-stated objectives; Setting goals, translating goals into objectives; Contextualising ADDIE process within the Extension learning environment.

**Unit VI: Instructional Strategies**

Organizing content and learning activities - scope and sequence of instruction; Posner's levels of organizing (Macro, Micro, Vertical, and Horizontal) and structures of organizing (content vs. media) instruction, Gagne's events of instruction, Edgar Dale's Cone of Experience; Methods of Delivery-classroom teaching, programmed instruction, synchronous and asynchronous modes of distance education; Changing role of a teacher in classroom and teaching competencies.

**Unit VII: Evaluating Instruction**

Meaning of Assessment, Measurement and Evaluation; Developing learner evaluations and their reliability & validity; assessment techniques for measuring change in knowledge, skill and attitude of learners - Objective Test Items, Constructed-Response Tests, Direct Testing, Performance Ratings, Observations and Anecdotal Records, Rubrics, Portfolios, Surveys and Questionnaires, Self Reporting Inventories, Interviews; Conducting learner evaluation pre-, during and post-instruction*;* Formative and Summative Evaluation- meaning, approaches and steps; Evaluating Learner Achievement and the Instructional Design Process; Evaluating the success of instruction; Performance appraisal of teachers.

**Unit VIII: Trends in Instructional Design**

Alternatives to ADDIE model - Rapid prototyping and constructivist ID, reflections on instructional design as science and as an art; Relating ID models and process in extension learning environment; political economy of higher education in developed and developing countries; University assessment and rating methods, returns from agricultural higher education; research in education and instructional design.

**Practical**

Exercises on preparation of the Analysis Report that includes the task/content analysis and learner analysis and the Design Plan includes learning objectives and corresponding instructional strategies and assessment items. Prepare course outline and lesson plan with an appreciation for diverse learning styles based on temperament, gender, and cultural/ethnic differences and deliver a lecture for UG/PG students. Assessing learning styles through Barsch and Kolb inventories. Development and testing of survey instruments for evaluating learning outcomes/ competencies of students. Development and testing of survey instruments for performance appraisal / competency assessment of teachers. Design an online e-learning module on a topic of interest as a capstone project - integrate and apply the knowledge and skills gained from the course for creating an effective learning experiencefor a target audience. Designing and developing a theme based knowledge portals • Exercises on designing an online course using open source LMS like moodle or EdX. Select and evaluate or design for social al media. Prepare a short research paper on recent theories and models of instructional design. Interview an instructional designer of your choice and prepare a synthesis report about what job roles he/she perform, What ID processes does he or she use, challenges faced. Develop a prototype for one of the lessons in your design plan using PowerPoint or a website builder such as Weebly to create the screens integrating multimedia content and various functionalities. Field visit to a virtual learning / augmented learning lab, e-learning labs, distance learning centres, etc. Hands-on practice with video-editing software, web conferencing and video conferencing solutions.

**Ext.-605 Risk Management and Climate Change Adaptation** **2+1** **Sem. I**

**Unit I: Management in Agriculture: Understanding Risk and Distress**

Introduction to risk, risk management, uncertainty, sensitivity and distress, General risk Theory, Riskanalysis methods, Risk perception and decision making, Indicators of risk and distress in agriculture identification, selection and assessment, Understanding the agrarian distress in Indian agriculture, Sources of distress in Indian farming -changing farm size, land use, cropping patterns, pricing policy, markets and terms of trade, Typology of crisis in agriculture; Droughts, floods and Indian agriculture, Distress and farmer suicides - causes and socio-economic consequences.

**Unit II: Managing Risk and Distress**

Ways to reducing/managing risk and distress in Indian agriculture; crop and life insurance; Developing support systems; Planning, implementation and evaluation of risk/distress management programs;

Institutional frameworks for risk and disaster management - NDMA & SDMAs; Developing District Agriculture Contingency Plans; Risk management by diversification; Good practices and lessons from other countries; Responses of government, non-government and extension system to agrarian crisis; National Farmers Policy.

**Unit III: Extension Professionals and Risk management**

Understanding social-psychological and behavioural dimensions of farmers under risk/distress; Risk perception and communication; Helping farmers manage farm level risks - mobilising resources, linking with markets, strengthening capacities; Working with village level risk management committees; Operational skills for preparing contingency and disaster management plans; Institutional and extension innovations in managing risk and distress; Policy and technological preferences for dealing with drought and flood.

**Unit IV: Adapting to Climate Change: Introduction to Climate Change Science**

Basic concepts of and terms in climate change science; impacts of climate change;anthropogenic drivers of climate change, Climate change and Indian agriculture; climate adaptation vs. disaster risk reduction; anticipated costs of adaptation; climate change and poor; Overview of UNFCCC framework and institutions, Kyoto Protocol and beyond; India's National Action Plan on Climate Change and National Mission on Strategic Knowledge on Climate Change; National Coastal Mission,Institutional arrangements for managing climate change agenda.

**Unit V: Introduction to Climate Change Adaptation and Mitigation**

Introduction to Climate Change Adaptation, Conducting a vulnerability assessment (CVI and SEVI frameworks), Identifying and selecting adaptation options; Global, national and state level initiatives and plans to support climate change adaptation, private sector and civil society initiatives and activities; Mainstreaming climate change adaptation into development planning, Financing climate adaptation and budgetary allocations for programmes, Gender and climate change adaptation, Agricultural development programmes and strategies towards climate change adaptation and mitigation, Community based and Ecosystem based adaptation strategies, preparing evidence based intervention plans for vulnerability reduction at micro and macro-levels.

**Unit VI: Climate Smart Agriculture (CSA) and Extension &Advisory Services**

Climate smart agriculture; Developing climate smart and climate resilient villages; Stakeholders and determinants involved in climate smart agriculture; Climate smart agriculture and EAS; Innovative extension approaches used in CSA; Climate information services, Farmers perceptions about climate change; Farm and household level manifestations and adaptation strategies; Barriers and limits to adaptation; Farmers feedback on performance of extension methods; Skills, competencies and tools required for extension professionals at different levels and development departments in up scaling CSA.

**Practical**

Hands-on practice in using risk assessment/analysis tools. Case studies on risk / distress assessment in agriculture -Indian and global. Lessons / Experiences from NICRA Project in agriculture and allied sectors. Developing criteria, indicators and indices for assessment of risk, vulnerability and resilience. Hands on practice on use of vulnerability and risk assessment tools and techniques. Case studies on success stories of climate change adaptation and community based initiatives. Developing district and village level intervention plans for climate change adaptation. Field Visits to State Disaster Management Authority. Case studies on climate smart agriculture / villages from India and world. Case studies on impact assessment of crop insurance programs, disaster management programs. Capstone project on documenting ITKs and local practices related to reducing risk / climate resilience agriculture.

**Ext.-606 Livelihood Development** **1+1** **Sem. I**

**Unit I: Understanding of Livelihood: Concept of Livelihoods**

Basic concepts of livelihood and Development, Types of development-Immanent/ inherent and interventionist/ intentional; Why promote livelihood; Livelihood intervention: definition, types-Spatial,

segmental, sector –sub-sector; Systemic view of Livelihoods, Understanding Rural Livelihoods-Farm, Non-Farm, and off farm; Linkages with Farm and Off-farm Livelihoods; EconomicModels.

**Unit II: Livelihood Challenges**

Livelihood Challenge- Political economy of Livelihoods, Issues of access to farm and non-farm livelihoods; Livelihoods from a Gender Perspective-Feminization of agriculture/ poverty, womenin the unorganized sector, the issue of unpaid andinformal work; Livelihood Coping Mechanism- Climate Change and Livelihoods; Livelihoods and Disasters.

**Unit III: Livelihood Analysis: Livelihood Frameworks**

Sustainable Livelihoods Approaches (SLAs)-Definition and origins of SLA; Assets or capitals and capabilities in SLA and its linkage to the other capitals: Physical, Social, Economic, Human, Natural; Vulnerability Assessment- Shocks, trends, seasonality; Policies, institutional context and processes; Conceptual Frameworks DFID, CARE, UNDP, OXFAM, BASIX livelihood triad, Nine square Mandala or Rural Livelihood System's Framework, etc.; Past, Present and possibilities for the future of the SLA, critiques of the approach.

**Unit IV: Designing Livelihood Intervention and Promotion**

Designing a suitable livelihood intervention-Observing and Understanding the Local Economy; Selecting livelihood activities suitable for the poor in the area; Deciding on the interventions. Livelihood promotion approaches-Poverty and livelihood: Approaches and programs in India; Livelihood and a Rights Based Approach MGNREGA and its critique; Livelihood and a Social Capital based approach: NRLM.

**Unit V: Livelihood Augmentation (LA): Pathways for LA**

Basic concepts; Pathways: a) Entrepreneurial strategies for LA; b) NRM based intervention; c) Market based interventions including Value-chain analysis; d) ICT based interventions; e) Livelihood and allied agriculture (dairy, poultry, Goatery, etc.) based livelihood; f) Forest based Livelihoods vis a vis Livelihood Protection and Promotion: Contribution of NTFP in supporting rural livelihoods Note: Block 'A' and 'B' is theoretical; Block 'C' should be covered in the form Practicals supported by few classroom discussion through cases.

**Practical**

Village stays to understand the livelihood pattern of villagers and how the other socio-economic factors affect the livelihood of people. Visit to institutes/ universities adopted and/or nearby villages to experience the life and natural resources in rural communities-understanding of village culture, evolution, social structure, livelihood pattern, trends, governance arrangements, and the natural context (landscape layout, land use, vegetation types etc). Application of participatory rural appraisal skills for understanding village context; Engagement of working with rural communities and their grass-root institutions, understanding dynamics of working in a group. Visit to different agri-business models as mentioned in the Block 'C'. Group assignments may be given to document the field experience in the form of case study of an enterprise/ entrepreneur/ members and other related stakeholders.

**Ext.-607 Facilitation for People Centric Development** **2+1** **Sem. II**

**Unit I: Introduction to Facilitation for Development**

Facilitation for development in the AIS,Facilitation for development in the AIS; Understanding facilitation for development; Importance offacilitation as a core function of extension within the Agricultural Innovation Systems (AIS).

**Unit II: Principles, Attributes and Skills for Facilitation for Development**

Basic principles of facilitation for development; Desired attributes of facilitator for development- Cognitive attributes, Emotional attributes (Emotional intelligence), Social, behavioural and attitudinal attributes; Technical skills of a facilitator for development- Design processes, Facilitation techniques and tools, the art of questioning and probing, Process observation and documentation,Visualisation.

**Unit III: Facilitating Change in Individuals, Groups and Organisations: Realise Potential- Self-Discovery**

Self-discovery to realise our potentials, Tools for self-discovery, formulating a personal vision, Taking responsibility for your own development.

**Unit IV: Group Dynamics and Working Together**

Understanding the dynamics of human interaction, Group dynamics and power relations, Managing relationships, Shared vision and collective action, Tools for team building.

**Unit V: Organizational Change Process**

Organizational change process, Organizational learning to adapt to changing environments,Enhancing performance of organizations, Leadership development, Tools for organizational change.

**Unit VI: Facilitating Operational Level Multi-stakeholder Engagements: Multi-StakeholderInteractions**

Defining stakeholders, Development of collective and shared goals, Building trust and accountability,Tools for stakeholder identification and visioning.

**Unit VII: Innovation and Policy engagement Platforms**

Visualising innovation platforms (IPs), Why are IPs important? Different models of IPs for multi- stakeholder engagement, policy engagement platforms, Generating issues and evidence for policy action, Advocacy for responsive policy processes.

**Unit VIII: Brokering Strategic Partnerships, Networking and Facilitation: Linkages, Partnerships, Alliances and Networking**

Brokering linkages and strategic partnerships, Identification of critical links, Knowledge brokering, Creating linkages with markets, Learning alliances and networking, Coordination of pluralistic service provision within the AIS, The concept of action learning and reflective practitioners, Networking.

**Unit IX: Facilitating Capacity Development**

Facilitating Capacity Development-Facilitate participation and learning in development programs and projects. Virtual platforms- skills for strengthening dialogue, collaboration, shared commitment amongst diverse actors and stakeholders.

**Practical**

Practicing facilitation techniques. Self-discovery exercises. Working together and interaction (task based). Arrangement for multi-stakeholder interactions. Understanding organisational change process tools and techniques. Case analysis on organisational change process. Participating with innovation platforms. Policy engagement platform. Stakeholder analysis mapping. Exercise on networking skills. Facilitating capacity building programmes. Facilitating virtual platforms. Filed visit to multi-stakeholder partnership projects.

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|---|---|
| **Ext.-691 Seminar I** | **1+0** |
| **Ext.-692 Seminar II** | **1+0** |
| **Ext.-699 Ph.D. Research** | **0+75** |

# AGRICULTURAL METEOROLOGY

## PROGRAMMES

**M.Sc. Agricultural Meteorology**
**Ph.D. Agricultural Meteorology**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of Specialization | Climate Change, Microclimate Modifications, Crop Modeling, Crop weather interactions, Crop weather-pests interactions,Applications of RS and GIS in Agricultural Meteorology |
| Core courses | AGM-501, AGM-502, AGM-504 |
| Minor Field | Agronomy, Entomology, Plant Pathology, Soil Science, Math., Vegetable Science or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Stat. - 502 and courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problems |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Climate Change, Microclimate Modifications, Crop Modeling, Crop weather interactions, Crop weather-pests interactions,Applications of RS and GIS in Agricultural Meteorology |
| Core courses | AGM-601, AGM-608 |
| Minor Field | Agronomy, Entomology, Plant Pathology, Soil Science, Math., Vegetable Science or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problems |
| Deficiency Courses | Deficiency courses for students AGM-501, AGM-502, AGM-504 with M.Sc. (Agri.) in a discipline other than Agricultural Meteorology and other courses as recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Course

**Agromet 51 Elementary Agro-Climatology 1+1 Sem. II**

General climatology, Agrometeorology. Elements and factors of climate. Earth's atmosphere, Effects of climate on crops and livestock distribution and production. Weather hazards in Agriculture. Introduction to monsoons. Basics of weather forecasting. Agroclimatic regions of Punjab. Effects ofclimate change on agriculture.

**Practical:** Introduction to Agrometeorology. Instruments installed in observatory. Recording data in Meteorological observatory. Preparation of Ergo graph. Computation of atmosphere humidity. Analysis of wind using Wind Rose. Study of weather systems. Analysis of weather charts. Preparationand dissemination of weather forecast. Agro advisories.

## Undergraduate Courses

**Agromet. 102 Introductory Agrometeorology and Climate Change 2+1 Sem. II**

Agrometeorology - definition, Practical utility and scope. General climatology. Structure and composition of earth's atmosphere. Elements and factors of weather and climate - temperature, pressure, wind, solar radiation and moisture. Impact of climate on crops and livestock distribution and production. Agroclimatic indices - definitions and applications in agriculture. Effect of environmental factors on crop growth. Weather hazards in agriculture. Climatic classifications. Agroclimatic regions of Punjab and India. Basics of field microclimate modification. Introduction to monsoons. Elementary aspects of weather forecasting. Effects of climate change on agriculture.

**Practical:** Site selection for Agrometeorological Observatory. Project on setting up, recording and maintenance of instruments in a meteorological observatory. Measurement of temperature, rainfall, evaporation, atmospheric pressure, sunshine duration, solar radiation, wind direction, wind speed and relative humidity. Study of weather forecasting and synoptic charts. Processing, presentation and interpretation of climatic data in relation to crops.

**Agromet. 301 System Simulation and Agroadvisory 2+1 Sem. II**

Systems approach for representing soil-plant-atmospheric continuum, system boundaries. Crop models –concepts, types, techniques, basic data requirements, relational diagrams. Evaluation of crop responses to weather elements. Elementary crop growth models, Calibration, validation, verification and sensitivity analysis. Potential and achievable crop production-concept and modeling techniquesfor their estimation. Crop production in moisture and nutrient limited conditions. Components of soil water and nutrient balance. Insect and disease forecasting models. Weather forecasting, types, methods, tools and techniques, forecast verification. Value added weather forecast; ITK for weatherforecast and its validity. Crop-weather calendars. Preparation of agro-advisory bulletin based on weather forecast and crop simulation models and its effective dissemination.

**Practical:** Preparation of crop weather calendars. Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts. Working with statistical and simulation models for crop growth. Potential and achievable production. Yield forecasting, insect and disease forecasting models. Simulation with limitations of water and nutrient management options. Sensitivity analysis of varying weather and crop management practices. Use of statistical approaches in data analysis and preparation of historical and present meteorological data for medium range weather forecast. Feedback from farmers about the agro-advisory.

## Postgraduate Courses

**AGM-501 Fundamentals of Meteorology** **2+1** **Sem. I**

**Unit I**

Solar radiation and laws of radiation, greenhouse effect, albedo, and heat balance of the earth and atmosphere, variation in pressure and temperature with height, potential temperature, pressure gradient, cyclonic and anticyclonic motions, geostrophic and gradient winds, equations of motion, general circulation, turbulence, vorticity, atmospheric waves.

**Unit II**

Gas laws, laws of thermodynamics and their application to atmosphere, water vapour in the atmosphere, various humidity parameters and their interrelationships, vapour pressure, psychrometric equation, saturation deficit. Lapse rates-ascent of dry and moist air, stability and instability conditions in the atmosphere.

**Unit III**

Agromet observatory and analysis of weather data. Condensation, clouds and their classification. Evaporation and rainfall, the hydrological cycle, precipitation processes, artificial rainmaking, thunderstorms and dust storm, haze, mist, fog, and dew. Air masses and fronts, tropical and extra-tropical cyclones.

**Unit IV**

Effect of Earth's rotation on zonal distribution of radiation, rainfall, temperature, and wind, the trade winds, equatorial trough and its movement.

**Unit V**

Monsoon and its origin, Indian monsoon and its seasonal aspects- Onset, advancement and retreat of monsoon in different parts of India, Walker and Hadley cell, *El Nino, La Nina*, Southern Oscillation Index and their impact on monsoon.

**Practical :** Agromet observatory- different classes of observatories (A, B, C). Site selection and installation procedures for meteorological instruments. Measurement of weather parameters. Reading and recording, calculation of daily, weekly, monthly means. Totals of weather data. Weather chart preparation and identification of low-pressure systems and ridges. Statistical techniques for computation of climatic normals, moving average, etc.

**AGM-502 Fundamentals of Agricultural Meteorology** **2+1** **Sem. II**

**Unit I**

Meaning and scope of agricultural meteorology, components of agricultural meteorology, role and responsibilities of agricultural meteorologists.

**Unit II**

Importance of meteorological parameters in agriculture. Efficiency of solar energy conversion into dry matter production, meteorological factors in photosynthesis, respiration and net assimilation, basic principles of water balance in ecosystems. Soil- water balance models and water production functions.

**Unit III**

Crop weather calendars, weather forecasts for agriculture at short, medium and long-range levels, agromet advisories, preparation, dissemination and economic impact analysis. Use of satellite imageries in weather forecasting, synoptic charts and synoptic approach to weather forecasting.

**Unit IV**

Concept, definition, types of drought and their causes, prediction of drought, crop water stress index, crop stress detection, air pollution and its influence on vegetation, meteorological aspects of forest fires and their control

**Unit V**

Climate change, greenhouse effect, $CO_2$ increase, global warming and their impact on agriculture, climate classification, agro-climatic zones and agro-ecological regions of India.

**Practical :** Preparation of crop weather calendars. Development of simple regression models for weather, pest and disease relation in different crops. Preparation of weather based agro-advisories. Use of automated weather station (AWS).

**AGM-503 Crop-Weather Relationships** **2+0** **Sem. I**

**Unit I**

Understanding the influence of weather elements on crop growth, impact of climatic variability and extremes on crop production, climatic normals for crop production.

**Unit II**

Climatic requirements of major crops, temperature effect on crop growth, radiation impact and radiation utilization efficiency, humidity effect on crop performance, effect of soil temperature on seed germination and root growth, wind variation and crop growth.

**Unit III**

Meteorological indices to predict crop production. Interpretation of weather forecasts for various agricultural operations towards improved productivity, crop-weather relationship in dryland areas. Crop weather relationship of major horticultural crops of the region and agroforestry system.

**Unit IV**

Rhizosphere and microorganisms in relation to weather, fertilizer and water use efficiency in relation to weather.

**AGM-504 Agro-Meteorological Measurements and Instrumentation** **1+2** **Sem. II**

**Unit I**

Fundamentals of measurement techniques, **Theory** and working principles of barometer, thermometer, psychrometer, hair hygrometer, thermohygrograph, exposure and operation ofmeteorological instruments/ equipments in agromet observatories.

**Unit II**

Radiation and temperature measuring instruments- working principles of pyranometer, albedometer, photometer, spectro-radiometer, sunshine recorder, dew recorder, quantum sensors, pressure bomb apparatus, thermographs, and infra-red thermometer.

**Unit III**

**Precipitation and dew instruments**

working principles of rain gauge, self recording rain gauge, Duvdevani dew gauges. Wind instruments- working principles of anemometer, wind vane, anemograph.

**Unit IV**

Evapotranspiration and photosynthesis instruments- working principles of lysimeters, open pan evaporimeters, porometer, photosynthesis system, leaf area meter.

**Unit V**

Boundary layer fluxes, flux tower, soil heat flux plates, instruments to measure soil moisture and soil temperature.

**Unit VI**

Automatic weather station – data logger and sensors, nano-sensors for measurement of weather variables, computation and interpretation of data.

**Practical :** Working with the above instruments in the meteorological observatory, fields and laboratory, Recording observations of relevant parameters. Computation and interpretation of the data,Analysis of AWS data.

**AGM-505 Crop Micrometeorology** **2+1** **Sem. II**

**Unit I**

Properties of atmosphere near the Earth's surface, exchange of mass momentum and energy between surface and overlaying atmosphere, exchange coefficient, similarity hypothesis, shearing stress, forced and free convection.

**Unit II**

Molecular and eddy transport of heat, water vapour and momentum, frictional effects, eddy diffusion, mixing, zero plane displacement, temperature instability, eddy covariance technique, microclimate near the bare ground, unstable and inversion layers, variation in microclimate under irrigated and rainfed conditions, soil moisture and temperature variation with depth, non–dimensional numbers (Richardson number, Reynold number, Rossby number, Rayleigh number etc.), Exchange coefficients.

**Unit III**

Micrometeorology of plant canopies; distribution of temperature, humidity, vapour pressure, wind and carbon dioxide. Modification of microclimate due to cultural practices, intercropping, radiation distribution and utilization by plant communities, leaf temperature and its biological effects. Influence of topography on microclimate, shelter belts and wind breaks, microclimate in low plant area of meadows and grain fields, microclimate within forests, glass house and plastic house climates. Instruments and measuring techniques in micrometeorology.

**Unit IV**

Effects of ambient weather conditions on growth, development and yield of crops. Measurement of global and diffused radiation, measurement of albedo over natural surfaces and cropped surfaces. Net radiation measurement at different levels, PAR distribution in plant canopies and interception. Wind, temperature and humidity profiles in (a) short crops and (b) tall crops, energy balance over crops and LAI and biomass estimation. Remote sensing and its application in relation to micrometeorology.

**Practical :** Micrometerological measurements in crop canopies. Quantification of crop microclimate. Determination of ET and its computation by different methods.

**AGM-506 Evapotranspiration and Soil Water Balance** **2+1** **Sem. II**

**Unit I**

Energy concept of soil water, hydraulic conductivity and soil water flux, Theory on hydraulic conductivity in saturated and unsaturated soils. Physical factors concerning water movement in soil, concepts on evaporation, evapotranspiration, potential and actual evapotranspiration.

**Unit II**

Theories of evapotranspiration and their comparison, aerodynamic, eddy correlation, energy balance, water balance and other methods, their application under different agroclimatic conditions. Concepts of potential, reference and actual evapotranspiration - modified techniques.

**Unit III**

Influence of microclimatic and cultural factors on soil water balance, techniques of lysimetry in measuring actual evapotranspiration. Water use efficiency and scheduling of irrigation based on evapotranspiration. Water use efficiency and antitranspirants, computation of Kc values and their use. Irrigation scheduling based on climatological approaches.

**Unit IV**

Yield functions, water use efficiency and scheduling of irrigation based on evapotranspiration. Dry matter yield ET functions. Radiation instruments, advanced techniques for measurement of radiation and energy balance. Estimation of evapotranspiration through remote sensing.

**Practical :** Measurement of various components of soil water balance. Evaluation of hydraulic conductivity vs. soil moisture relationship by water balance approach. Computation and comparison of evapotranspiration by different methods - energy balance method, aerodynamic method, Penman method, remote sensing and other methods. Soil moisture retention characteristics by pressure plate method.

**AGM-507 Crop Weather Models** **1+2** **Sem. I**

**Unit I**

Principles of crop production, effect of weather elements on crop responses. Impact of natural andinduced variability of climate on crop production.

**Unit II**

Introduction and application to crop modeling, types of models. Empirical and statistical crop weather models their application with examples, concept of crop growth model in relation to weather, soil, plant and other environmental related parameters and remote sensing inputs, growthand yield prediction models.

**Unit III**

Dynamic crop simulation models, e.g. DSSAT, Info Crop, APSIM, Crop Syst, etc. optimization,calibration and validation of models. Weather data and physiology-based approaches to modeling of crop growth and yield. Forecasting of pests and diseases. Stochastic models, advantages and limitations of modeling.

**Practical :** Working with statistical and simulation models, DSSAT models, Info Crop, Oryza, etc.

**AGM-508 Applied Agricultural Climatology** **1+2** **Sem. I**

**Unit I**

Climatic statistics- measures of central tendency and variability, skewness, kurtosis, homogeneity, correlation, regression and moving averages. Probability analysis using normal, binomial, Markov- chain and incomplete gamma distribution. Parametric and non-parametric tests. Assessment of frequency of disastrous events.

**Unit II**

Precipitation indices. Climatic water budget. Potential and actual evapotranspiration and their computation. Measurement of precipitation, calculation of water surplus and deficit, computation of daily and monthly water budget and their applications. Assessment of dry and wet spells, available soil moisture, moisture adequacy index and their applications.

**Unit III**

Thermal indices and phenology. Cardinal temperatures, heat unit and growing degree day concepts for crop phenology, crop growth and development. Insect-pest development. Crop weather calendars. Agroclimatic requirement of crops.

**Unit IV**

Bioclimatic concepts- evaluation of human comfort, comfort indices (temperature, humidity index and wind chill) and clothing insulation. Climate housing and site orientation. Climatic normals for animal production.

**Practical :** Use of statistical approaches in data analysis. Preparation of climatic water budget. Estimation of agro- meteorological variables using historical records. Degree day concept and phenology forecasting and preparation of crop calendar. Evaluation of radiation, wind and shading effects in site selection and orientation. Study of weather-pest and disease interactions, calculation of continentality factors, calculation of comfort indices and preparation of climograph.

**AGM-509 Weather Forecasting** **2+1** **Sem. I**

**Unit I**

Weather forecasting system- definition, scope and importance. Types of forecasting, short, medium and long-range; study of synoptic charts with special reference to location of highs and lows, jet streams, synoptic features and weather anomalies and zones of thermal advection and interpretation of satellite pictures of clouds in visible and infra-red range. Weather forecasting network.

**Unit II**

Approaches for weather forecasts. Methods of weather forecasts - synoptic, numerical prediction, statistical, analogue, persistence and climatological approach, nano- technological approach, Indigenous Technical Knowledge (ITK) base - signals from flora, fauna, insects, birds, animals' behaviour. Various methods of verification of location- specific weather forecast.

**Unit III**

Special forecasts- special forecasts for natural calamities such as drought, floods, high winds, cold (frost) and heat waves, hail storms, cyclones and protection measures against such hazards.

**Unit IV**

Modification of weather hazards. Weather modification for agriculture. Scientific advances in artificial rain making, hail suppression, dissipation of fog and stratus clouds, modification of severestorms and electric behavior of clouds.

**Unit V**

Weather based advisories- interpretation of weather forecasts for soil moisture, farm operations, pest and disease development and epidemics, crops and livestock production, preparation of weather-based advisories and dissemination.

**Practical :** Exercise on weather forecasting for various applications. Preparation of weather-based agro-advisories based on weather forecast using various approaches and synoptic charts.

**AGM-510 RS and GIS Applications in Agricultural Meteorology** **2+1** **Sem. I**

**Unit I**

Basic components of remote sensing- signals, sensors and sensing systems, active and passive remote sensing.

**Unit II**

Characteristics of electromagnetic radiation and its interaction with matter, spectral features of earth's surface features, remote sensors in visible, infrared and microwave regions.

**Unit III**

Imaging and non-imaging systems, framing and scanning systems, resolution of sensors, sensor platforms, their launching and maintenance. Drone technology.

**Unit IV**

Data acquisition system, data pre-processing, storage and dissemination, digital image processing and information extraction.

**Unit V**

Microwave remote sensing, visual and digital image interpretation. Introduction to GIS and GPS.

**Unit VI**

Digital techniques for crop discrimination and identification, crop stress detection - soil moisture assessment, inventory of ground water and satellite measurement of surface soil moisture and temperature. Drought monitoring, monitoring of crop disease and pest infestation. Use of satellite data in weather forecasting.

**Unit VII**

Soil resource inventory, land use/land cover mapping and planning. Integrated watersheddevelopment. Crop yield modeling and crop production forecasting.

**Practical :** Acquisition of maps. Field data collection. Map and imagery scales. S/W and H/W requirements and specifications for remote sensing. Data products, their specifications, media types, data inputs, transformation, display types, image enhancement. Image classification methods. Evaluation of classification errors. Crop discrimination and acreage estimations. Differentiation of different degraded soils. Time domain reflectometry. Use of spectrometer and computation of vegetation indices. Demonstration of case studies. Hands on training.

**AGM-511 Strategic Use of Climatic Information 2+1 Sem. II**

**Unit I**

Increasing awareness on potential climate hazards and mitigations. History of climate- related disasters in the concerned continent/region/country/sub-region and their documented or remembered impacts. Climatic hazards and extreme weather events (Cyclone, Hailstorm, drought,flood, etc.), impact of climatic hazard on agricultural production, efforts made in mitigating impacts of (future) disasters (prevention), trends discernible in occurrence and character of disasters, if any.

**Unit II**

Selection of appropriate land use and cropping patterns- types and drivers of agricultural land use and cropping patterns based on climatic situation. History of present land use and cropping patterns in the sub-region concerned as related to environmental issues, successes and difficulties experienced by farmers with present land use and cropping patterns. Outlook for present land use and cropping patterns and possible alternatives from an environmental point of view.

**Unit III**

Adoption of preparedness strategies- priority settings for preparedness strategies in agricultural production, preparedness for meteorological disasters in development planning, permanent adaptation strategies that reduce the vulnerabilities to hazards, preparedness as a coping strategy.

**Unit IV**

Making more efficient use of agricultural inputs- agro-meteorological aspects of agricultural production inputs and their history, determination of input efficiencies based on weather conditions, other factors determining inputs and input efficiency, actual use of inputs in main land use and cropping patterns of the region.

**Unit V**

Adoption of microclimate modification techniques - review of microclimate management and manipulation methods, history of microclimate modification techniques practiced in the continent/ country/sub-region concerned. Possible improvements in adoption of microclimate modification techniques, given increasing climate variability and climate change, local trends in adoption of such techniques.

**Unit VI**

Protection measures against extreme climate- history of protection measures against extreme climate in the continent/region/country/sub region concerned, successes and difficulties experienced by farmers with present protection measures, outlook for present protection measures and possible alternatives. Trends in protection methods against extreme climate.

**Practical**

Outlook for present land use and cropping patterns and possible alternatives from environmental point of view. Recent trends in land use and cropping patterns. Agro-meteorological services to increase farmers design abilities of land use and cropping patterns. Systematic and standardized data collection on protection measures against extreme climate.

**AGM-512 Weather and Climate Risk Management** **2+0** **Sem. II**

**Unit I**

Risk characterization - definitions and classification of risks, characterization of weather and climate related risks in agriculture, water related risks, radiation/heat related risks, air and its movement related risks, biomass related risks, social and economic risk factors related to weather and climate.

**Unit II**

Risks in agricultural production, history of weather and climate as accepted risk factors in agriculture in the continent/ region/ country/ sub-region concerned and the related documented risk concepts, preparedness for weather and climate risks.

**Unit III**

Risks of droughts, monitoring, prediction and prevention of drought, drought proofing and management. Modern tools including remote sensing and GIS in monitoring and combating droughts.

**Unit IV**

Theories of weather modification, scientific advances in clouds and electrical behavior of clouds, hails suppression, dissipation of fog, modification of frost intensity and severe storms. Shelter belts and wind breaks, mulches and anti-transpirants. Protection of plants against climatic hazards. Air and water pollution. Meteorological conditions in artificial and controlled climates - green, plastic, glass and animal houses etc.

**Unit V**

Approaches and tools to deal with risks - history of methods for weather and climate related risk assessments in the continent/region/ country/sub region concerned and their documented evidence of application to agricultural/farming systems, strategies of dealing with risks- mitigating practices before occurrence, preparedness for the inevitable, contingency planning and responses. Disaster risk mainstreaming.

**Unit VI**

Perspectives for farm applications - farm applications not yet dealt with, such as making risk information products more client friendly and transfer of risk information products to primary and secondary users of such information, heterogeneity of rural people in education, income, occupation and information demands and consequences for risk information products and their transfer, livelihood-focused support, participation and community perspectives and challenges for developing coping strategies including transferring risks through insurance schemes.

**Unit VII**

Challenges to coping strategies-combining challenges to disaster risk mainstreaming, mitigation practices, contingency planning and responses, basic preparedness, preparedness approaches reducing emergency relief necessities, the role that insurances can play in risk spreading and transfer. Application of methods that permit the incorporation of seasonal and long-term forecasts into the risk assessment models.

**AGM-513 Aerobiometeorology** **2+1** **Sem. I**

**Unit I**

Definition and structure of aerobiometeorology, role of agrometeorology and biogeography in forecasting pests and disease outbreak, insect movement in the atmosphere, intensification, effectof weather & climate parameters on reproduction, growth, development, movements, food, habitat and dispersal of pests and diseases. Influence of weather & climate on Migratory pests (Desert locust, BPH etc.).

**Unit II**

Benevolent and malevolent weather conditions for salient pests & diseases of the concerned agro-climatic zones. Effects of sudden weather changes and extreme weather conditions on population built-up of the pest, heat stress and heat related mortality, climate change impact on pest and diseases.

**Unit III**

Biometeorology in integrated pest and disease management program, modification of plant canopyand its impact of plant diseases, management of segments of disease triangle, environment manipulation and host manipulation, weather based forewarning system for pest and diseases.

**Unit IV**

Soil borne pathogens, their biology, management and challenges, soil borne diseases and their control, abiotic factor in soil borne disease management. Managing of pests & diseases in controlled environment. Environmental management for pest and disease.

**Practical :** Pest population, observations and their index calculation. Disease initiation and their intensity,percent disease index Relation between weather parameters and pests and disease.

**AGM-591 Seminar** **1+0**

**AGM-599 Master's Research** **0+30**

## Ph.D. courses

**AGM-601 Climate Change and Sustainable Development** **2+1** **Sem. I**

**Unit I**

Climate change and global warming- definitions of terms, causes of climate change and global warming, greenhouse gases, ozone depletion, past records, present trends, extreme weather events and future projections. Case studies on various climatic projections and consequences thereof in relation to agriculture.

**Unit II**

Impacts of climate change on various systems- impacts resulting from projected changes on agriculture and food security, hydrology and water resources, terrestrial and freshwater ecosystems, coastal zones and marine ecosystems, human health, human settlements, energy, and industry, insurance and other financial services. Climate change and crop diversification, loss of biodiversity, microbes and pest dynamics, climate change and storage and weed management. Advance methodology of assessing the impact of climate change on crops.

**Unit III**

Sensitivity, adaptation and vulnerability-system's sensitivity, adaptive capacity and vulnerability toclimate change and extreme weather events, regional scenarios of climate change and variability.

**Unit IV**

Mitigation strategies for sustainable development- international policies, protocols, treaties for reduction in greenhouse gases and carbon emissions, carbon sequestration, carbon credit; clean development mechanism (CDM) and land use. Crop management options for low emission, land usechange and forestry mechanism, alternate energy sources etc.

**Unit V**

Agricultural food security- reduction in carbon and GHG emission, fuel conservation and reduction inenergy use, conservation tillage, biofuels for fossil fuels, reduction in machinery use etc., increasing carbon sinks, resource conservation technologies, mixed rotations of cover and green manure crops, minimization of summer fallow and no ground cover periods, etc.

**Practical :** Case studies on various climatic projections and consequences thereof in relation to agriculture.Advance methodology of assessing the impact of climate change on crops.

**AGM-602 Meteorology of Air Pollution** **2+2** **Sem. II**

**Unit I**

Introduction to air pollution- history, definition- clean air definition, natural versus polluted atmosphere, atmosphere before the industrial revolution. Real time air quality index and National air quality index.

**Unit II**

Sources of air pollution, classification and properties of air pollutants, emission sources, importance of anthropogenic sources, behaviour and fate of air pollutants, photochemical smog, pollutants and trace gases. Acid rain and development of Gas Washing.

**Unit III**

Meteorological factors in the dispersion of air pollutants, topographical, geographical and large-scale meteorological factors attached air pollution. Planetary Boundary Layer (PBL) and mixing layer, meteorological conditions and typical plume forms, air pollution forecasting – Gaussian diffusion models, Numerical dispersion models.

**Unit IV**

Air quality standards, effect of air pollution on biological organisms, ozone layer depletion, air pollution control technologies, management of air pollution, principles of diffusion of particulate matter in the atmosphere, air pollution laws and standards. Scales of air pollution- local, urban, regional, continental and global.

**Unit V**

Air pollution sampling and measurement- types of pollutant sampling and measurement, ambient air sampling, collection of gaseous air pollutants, collection of particulate pollutants, stock sampling, analysis of air pollutants - sulfur dioxide, nitrogen dioxide, carbon monoxide, oxidants and ozone, hydrocarbons, particulate matter.

**Practical :** Measurement of different air pollutants. Measurement of different air pollution gases. Measurement of visibility. Measurement of ozone and aerosol optical thickness (AOT). To study the temperature profile at different heights. To study the stability of the atmosphere. To determine height of partialflume through chimani. To study the effect of temperature on vegetables, orchards and agricultural crops.

**AGM-603 Livestock and Fisheries Meteorology** **2+2** **Sem. I**

**Unit I**

Thermal balance in animals, energy exchange processes at the skin of the animals and the need forthe maintenance of thermal balance in the animals. Animal traits and physiological responses.

**Unit II**

Effects of weather on animal production, loss of water from the body, growth rate and body weight, reproduction, grazing habit, food intake, milk production, sun burns and photosensitive disorders.

**Unit III**

Meteorological conditions prevailing in glass-house, green house, animal shed, poultry house and grain storage barns, heating, cooling and ventilation of these structures as governed by meteorological factors. Environmental modification within the shelters of livestock. Applications of biometeorological information for rational planning, design and management. Weather and animal diseases and parasites, diseases of poultry and its relation with weather and thermal comfort.

**Unit IV**

Livestock production and climate change, management of livestock to reduce greenhouse gas emission.

**Unit V**

Weather effect on fish behaviour. Water temperature affecting fish activity. Marine weather and fishing. Climate change and fisheries production.

**Practical :** Measurement of meteorological parameters within the shelters of livestock. Calculation of animal comfort zone index. Radiation of animal farm house and body. Estimation of energy fluxes on body. Measurements of CO2 and methane in animal farm house. Microclimate measurements in climate resilient animal sheds.

**AGM-604 Hydrometeorology** **2+1** **Sem. II**

**Unit I**

Hydrologic cycle and its modification, rainfall and its interception by plants and crops. Interpolation and measurement of missing rainfall data, adequacy of rain gauges, average rainfall on an area depth basis, presentation and processing of precipitation data.

**Unit II**

Measurement of runoff, infiltration, moisture retention of soil, percolation, evaporation, evapotranspiration and its importance to agriculturists, irrigation engineers and flood forecasting personnel, water holding capacity of soils, plant available water, cultural practices on soil moisture in relation to different phases of crop growth, evaporation from snow, lakes, reservoirs and crop fields.

**Unit III**

Classifying rainfall data into class interval; ranking of rainfall data, relationship between intensity and duration. Methods of predicting runoff rate, factors affecting runoff, rainfall- runoff relation, estimation of evapotranspiration from water balance methods, response of crops to water stresses under different agroclimatic situation on India.

**Unit IV**

Moisture availability indices and their application for Indian condition, wet and dry spell by Markov-chain model. Drought and its classification, hydrological drought, drought indices and their applications under Indian conditions.

**Practical :** Analysis of rainfall data. Determination of effective rainfall. To estimate missing rainfall data for a given station. To find out the optimum number of rain gauges for a given catchment. To find out the mean rainfall for a given drainage basin by Thiessen polygon method and isohyetal method. To estimate the volume of runoff by SCS method. Estimation of evopotranspiration from field-based water balance method.

**AGM-605 Analytical Tools and Methods for Agrometeorology** **1+1** **Sem. I**

**Unit I**

Review of agro-climatic methods, characterization of agroclimatic elements, sampling of atmosphere, temporal and spatial considerations, micro-meso-macro climates.

**Unit II**

Network spacing; spatial and temporal methods. GIS fundamentals and applications. Numerical characterization of climatic features. Crop response to climate, time lags, time and distance constants and hysteresis effects.

**Unit III**

Influence of climate on stress-response relations, thermal time approach in agroclimatology- heat and radiation use efficiency in crop plants, applications to insect- pest development and prediction, comfort indices for human and animals. Impact of natural and induced variability and change of climate on crop production.

**Unit IV**

Instrumentation and sampling problems, design of agrometeorological experiments.

**Unit V**

Basic knowledge of application of computers in agriculture, theories of computer language BASIC, FORTRAN, C, C++ and Visual basic.

**Unit VI**

Empirical and statistical crop weather models and their application with examples, incorporating weather, soil, plants and other environment related parameters as subroutine and remote sensinginputs in models, growth and yield prediction models, crop simulation models, forecasting models for insects and diseases.

**Practical :** Calculation of continentality factors. Climatic indices and climogram. Agrometeorological indices- Degree-days, photothermal units, heliothermal units, phenothermal index. Heat and radiation use efficiency and other indices of crops. Crop growth rates. Analysis of thermogram, hygrogram, yetogram, sunshine cards etc. stream lines and wind roses and statistical analysis of climatic data. Working with statistical models- crop yield forecasting, crop weather relationship and insect & disease forecasting models. Working with crop simulation models. Small programme writing in latest computer languages. Geographical Information System.

**AGM-607 Environmental Physics for Agricultural Meteorology 3+0 Sem. I**

**Unit I**

Thermodynamics of the atmosphere. Physics of radiation- origin and nature of radiation, radiation geometry in Cartesian, spherical cylindrical coordinate systems, conservation principles for radiantenergy, fluid motion- laminar and turbulent transfer, fluctuation **Theory** for turbulent transfer of momentum, heat and water vapour.

**Unit II**

Physics of evaporation- aerodynamic approach, energy balance approach and combination approach for evaporation estimates.

**Unit III**

Physics of soil water system- the concept of potential as applied to soil water system, total potential and components, movements of water on soil, fundamental equation, hydraulic conductivity, infiltration, field drainage and water vapour movement in soil.

**Unit IV**

Physics of water use- a physical introduction to plant-water system and relationships, water transport through soil-plant-atmosphere systems, measurement of crop water use in terms of water conservation equation.

**AGM-608 Computer Programs and Software for Agrometeorological Data Management 1+1 Sem. II**

**Unit I**

Data and information; types of data, climate, soil and crop data. Importance of database management, softwares related to database management, data requirements, data collection andrecording (Automatic and manual).

**Unit II**

Data structure/format, quality control of data through computer software, techniques of climatic data generation, missing data, introduction to different software for database management.

**Unit III**

Processing and analysis of data and data products, value addition of data and data products, data users, public, commercial, academic or research. Availability, accessibility and security of data, evaluating the cost of data, e-management of data. Meta analysis - Advantages and problems, Steps,Approaches and methods, Applications.

**Unit IV**

Computer Programming- History, quality requirements, readability of source code, Algorithmic complexity, Debugging and Programming languages.

**Practical :** Types of instruments and data recording. AWS data retrieval, storage and transfer. Exposure to different software for Agromet data analysis, exposure to Statistical software. Temporal and spatial analysis of data; exposure to GIS. Value addition to data. Introduction to internet protocols. Uploading and downloading data, password and security of data. E-management of data. Introduction to computer programming.

**AGM-691 Seminar I 1+0**

**AGM-692 Seminar II 1+0**

**AGM-699 Ph.D. Research 0+75**

# AGRONOMY

## PROGRAMMES

**M.Sc. Agronomy**
**Ph.D. Agronomy**

## COURSE REQUIREMENTS

### M.Sc.

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| Field of Specialization | Agrostology, Crop Ecology, Crop Nutrition, Crop Physiology, Crop Production, Water Management, Weed Science |
| Core Courses | Agron.-501, Agron.-502, Agron.-503, Agron.-504, Agron.-505 |
| Minor Field | Agricultural Meteorology, Chemistry, Botany, Soil Science, Forestry & Natural Resources, Microbiology or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Stat.-502 and courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problems |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

### Ph.D.

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|---|---|
| Field of Specialization | Agrostology, Crop Ecology, Crop Nutrition, Crop Physiology, Crop Production, Water Management, Weed Science |
| Core Courses | Agron.- 601 |
| Minor Field | Agricultural Meteorology, Chemistry, Botany, Soil Science, Forestry & Natural Resources, Microbiology or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Courses from subject matter fields (other than Major and Minor)relating to area of special interest and research problems |
| Deficiency courses | As recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Courses

**Agron. 51 Elementary Agriculture 1+1 Sem. I**

Agriculture and its component sciences. Classification of crops. Seed, its structure, germination, phases of growth, factors affecting growth. Seed bed preparation. Nutrients for plant growth. Fertilizers and manures. Importance of water to plants, its uptake and losses. Weeds and their control.

**Practical:** Identification of various crops and seed. Study of germination of different types of crop seeds. Familiarization of important agricultural implements and hand tools, weeds, fertilizers.

**Agron. 52 Elementary Agronomy 2+1 Sem. I**

Agronomy - its importance and relation with other sciences. Classification of crops. Tillage - principles and practices. Different methods of sowing. Common manures and fertilizers and their time and method of application. Green manuring. Methods of irrigation. Weeds and their control. Cropping systems, crop rotations and inter-cropping. Harvesting and threshing. Conservation agriculture.

**Practical**: Land measurements. Use of common hand tools and farm implements. Identification of different fertilizers. Computation of fertilizer doses. Methods of fertilizer application. Germination and purity test. Use of spray pumps. Practice in harvesting and threshing. Farm visit for familiarization with field problems.

**Agron. 53 Crop Production – I 2+1 Sem. I**

Important *kharif* crops – rice, maize, bajra, cotton, sugarcane, moong, mash, red gram, soybean, groundnut, sesamum, mentha, turmeric and fodder crops, their importance, improved varieties, cultural practices, harvesting and threshing.

**Practical:** Identification of important *kharif* crops, their seeds and weeds. Field practices like seedbed preparation, seed treatment, preparation of sugarcane seed sets, sowing, transplanting, thinning, earthing up, hoeing, fertilizer and herbicide application, propping, maturity indexing and harvesting.

**Agron. 54 Crop Production – II 2+1 Sem. II**

Important *rabi* crops – wheat, winter maize, gram, lentil, rapeseed and mustard, sunflower, safflower, celery and fodder crops, their importance, improved varieties, cultural practices, harvesting and threshing.

**Practical:** Identification of important *rabi* crops, their seeds and weeds. Field practices like seedbed preparation, seed treatment, sowing, transplanting, thinning, earthing up, hoeing, fertilizer and herbicide application, maturity indexing and harvesting.

Undergraduate Courses

**Agri I: Introduction to Agriculture (1+0 NC) Sem.II**

**(For the students of B.Sc. (Hons.) Agri 2+4- Year Programme)**

Introduction to agriculture - definition, importance, etc. Historical perspectives of agriculture. Branches of agriculture. Allied sciences of agriculture - horticulture, forestry, veterinary science etc. Scope of agriculture- job avenues and entrepreneurship opportunities. Green Revolution in India - need and Impact. Different agricultural revolutions – white, blue, yellow etc. Introduction to different types of crops and cropping seasons.

**Agri II: Agricultural Status of Punjab (1+0 NC) Sem.I**

**(For the students of B.Sc. (Hons.) Agri 2+4- Year Programme)**

Agricultural history of Punjab. Important crops of Punjab. Native and introduced crops. Present status of major crops, area, production, yield. Total share of agriculture in SGDP. Dependence of state population on agriculture. Different categories of farmers. Agro climatic zones in the Punjab state. Irrigation sources, consumption of pesticides, fertilisers etc. in Punjab. Agricultural machinery and implements. Major issues of agriculture in Punjab state.

**Agri III: Agricultural Status of India (1+0 NC)** **Sem.II**

**(For the students of B.Sc. (Hons.) Agri 2+4- Year Programme)**

Agricultural history of India. Important crops of India. Native and introduced crops. Present status of major crops - area, production yield. Total share of agriculture in country's GDP, Major agricultural produce exported and imported. Dependence of population on agriculture in country. Different categories of farmers. Irrigation sources, consumption of pesticides, fertilisers, etc, in the country. Major issues of agriculture in the country.

**Agron. 101 Fundamentals of Agronomy** **3+1** **Sem. I**

Agronomy and its scope. History of agriculture and impact of green revolution on Indian agriculture. Seeds and sowing, tillage and tilth. Crop density and geometry. Crop nutrition, manures and fertilizers, nutrient use efficiency. Water resources. Soil-plant-water relationship, crop water requirement, water use efficiency. Irrigation- scheduling criteria and methods, quality of irrigation water, water logging. Weeds-importance, classification, crop weed competition, concepts of weed management-principles and methods, herbicides-classification, selectivity and resistance, allelopathy. Growth and development of crops. Cropping system and its diversification in present day agriculture. Factors affecting growth and development. Plant ideotypes. Crop rotation and its principles. Adaptation and distribution of crops. Crop management technologies in problematic areas. Harvesting and threshing of crops.

**Practical:** Identification of crops, seeds, fertilizers, pesticides and tillage implements. Study of agroclimatic zones of India. Identification of weeds in crops, methods of herbicide and fertilizer application. Study of yield contributing characters and yield estimation. Seed germination and viability test. Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement. Use of tillage implements-reversible plough, one way plough, harrow, leveller, seed drill. Study of soil moisture measuring devices, measurement of field capacity, bulk density and infiltration rate. Measurement of irrigation water.

**Agron. 102 Principles of Agronomy** **1+1** **Sem. II**

**(For students of B. Tech. Agri. Engineering)**

Introduction and scope of Agronomy. Classification of crops. Effect of different weather parameters on crop growth and development. Principles of tillage, tilth and its characteristics. Modern concepts of tillage. Crop seasons. Varieties, methods, time and depth of sowing, weed control, irrigation and fertilizer management of major field crops. Methods and time of application of manures and fertilizers. Precision agriculture. Organic farming. Sustainable agriculture. Soil water plant relationship, methods of irrigation, water requirement of crops and critical stages for irrigation. Weeds and their control. Crop rotation, cropping systems, relay cropping and mixed cropping.

**Practical:** Land measurement. Identification of crops, seeds, hand tools, implements, fertilizers and weeds. Calculation of fertilizer doses, fertilizer application methods. Different weed control methods. Practice of ploughing, practice of puddling, practice of sowing.

**Agron. 103 Crop Production Technology** **2+1** **Sem. I**

**(For students of B.Tech. Biotechnology - In collaboration with Department of Soil Science)**

Soil and its components. Soil morphological, physical, chemical and biological properties. Acidic, saline and alkali soils and their reclamation. Essential plant nutrients-functions and deficiency symptoms. Soil micro-organisms. Rhizosphere and its domain in soil. Organic manures and inorganic fertilizers. Agriculture, Agronomy and its relation with other sciences. Classification of crops. Tillage and tillage practices, concepts of tillage and objectives. Seed, its characteristics and different sowing methods. Weed management-definition of weed, losses and benefits of weeds, different weed control methods and their suitability under different conditions. Irrigation-Soil water classification, methods of irrigation, approaches for scheduling irrigation. Soil fertility and productivity. Concept of essentiality of plant nutrients. Fertilizers, manures and their types, methods of fertilizer application. Concepts of crop rotation, multiple cropping and intercropping - their principles, advantages and limitations. Cropping intensity. Production technology of major Crops: rice, maize, cotton, soybean, moong, mash, wheat, rapeseed and mustard, gram and Egyptian clover.

**Practical:** Study of soil profile and its characteristics. Determination of soil particle size distribution,particle density and bulk density. Determination of soil pH, electrical conductivity and organic carbon. Isolation of soil micro-flora (bacteria, fungus and actinomycetes). Land measurement. Practice in seedbed preparation and seeding methods. Identification of crop seeds, crops, weeds and fertilizers. Identification and use of hand tools and implements. Computation of fertilizer dosesand their method of application.

**Agron. 104 Introduction to Major Field Crops 2+1 Sem. II**

**[For students of B.Sc. (Hons.) Horticulture]**

Classification and distribution of field crops, definition, concept and principles of multiple cropping, mixed cropping, intercropping, relay and alley cropping, crop rotation. Economic importance, soil and climatic requirement, varieties, cultural practices for raising major cereals (rice, maize, wheat), pulses (moong, arhar, gram, soybean), oilseeds (rapeseed and mustard, sunflower, groundnut), cash crops (sugarcane, cotton) and fodder crops (sorghum, *bajra*, *berseem*, oats). Principles and practicesof green manuring.

**Practical:** Identification of crop plants, seeds, weeds and fertilizers. Preparation of cropping scheme. Method of sowing, fertilizer and herbicide application in field crops. Calculation of fertilizer and herbicide doses.

**Agron. 105 Crop Production Practices 2+1 Sem. I**

**(For students of B. Tech. Food Technology - In Collaboration with Department of Fruit Science and Vegetable Science)**

Classification of crops. Effect of different weather parameters on crop growth and development. Principles of tillage. Soil-water-plant relationship. Crop rotation, cropping systems, relay cropping and mixed cropping. Crop production technology for major cereal crops viz., paddy, wheat, maize, pearl millet, sorghum, etc. Major varieties, sowing time, method of sowing, spacing, inter-culturing,fertilizer and water requirement, time of harvest, maturity index, yield potential, etc. Crop productiontechnology for major oilseed crops viz., groundnut, sesame, rapeseed, mustard, castor, etc. Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement,time of harvest, maturity index, yield potential, etc. Crop production technology for major pulse crops viz., pigeon pea, cowpea, gram, green gram, black gram, etc. Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential etc. Crop production technology for major spices and cash crops viz., cumin, coriander, fennel, ginger, garlic, sugarcane etc. Major varieties, sowing time, method ofsowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc. Horticulture - Scope of horticultural crops. Soil and climatic requirements for fruits and vegetables, nursery raising and management. Crop production technology for major fruit crops viz., mango, banana, sapota, *aonla*, pomegranate, guava, etc., Major varieties, time of transplanting, spacing, inter-culturing, fertilizer and water requirement, time and method of harvest, maturity index, yield potential, cost of cultivation, income from production, etc. Crop production technology for major vegetable crops viz., potato, onion, tomato, chilli and other green and leafy vegetables.

Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and waterrequirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.

**Practical:** Examination of soil profile in the field, introduction to different equipments utilized in a weather observatory. Identification of seed of different agricultural crops and their varieties. Studyof seed viability and germination test. Identification of different weeds and methods of their control. Use of different inter-culturing equipments. Study of water requirement of different crops. Fertilizer application methods and equipments. Judging maturity time for harvesting of crop. Identification and description of important fruit and vegetable crops. Preparation of nursery. Study of different garden tools. Practices of pruning and training in some important fruit crops.

**Agron. 107 Basic Agronomy and Production Technology for *Kharif* Crops 1+1 Sem.I**

**[For students of B.Sc. (Hons.) Agribusiness Management]**

Agriculture, and its scope, tillage and tilth, crop density and geometry, factors affecting growth and

development, crops and cropping systems, crop rotation and its principles, manures and fertilizers. Irrigation - water resources, crop water requirement, water use efficiency, irrigation-scheduling - criteria and methods. Weeds- importance, classification, crop weed competition, concepts of weed management-principles and methods, herbicides – methods of application. Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *kharif* crops viz. Rice, maize, sorghum, pearl millet, pigeon pea, mungbean, cowpea, urdbean, groundnut, soybean and sesamum.

**Practical:** Identification of crops, seeds, fertilizers, herbicides and tillage implements. Use of tillage implements like reversible plough, one way plough, harrow, leveler, seed drill. Identification of weeds in crops, methods of herbicide and fertilizer application, numerical exercises on fertilizer, methods of irrigation. Rice nursery preparation and transplanting, methods of sowing. Study of morphological characteristics of *kharif* crops, top dressing and foliar application of nutrients, study of yield contributing characters and yield calculation of crops, yield and juice quality analysis of sugarcane and visit to research centers of related crops.

**Agron. 201 Production Technology for *Kharif* Crops 1+1 Sem. I**

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *kharif* crops. Cereals- rice, maize, sorghum, pearl millet and finger millet; pulses- pigeon pea, mungbean and urdbean; oilseeds- groundnut and soybean; fibre crops- cotton and jute; forage crops- maize, sorghum, *bajra*, cowpea, cluster bean and Napier-*bajra* hybrid.

**Practical:** Rice nursery preparation and transplanting. Sowing of cotton, maize, soybean, pigeon pea, mung bean, groundnut and forage crops. Effect of seed size and sowing depth on germination and seedling vigour of *kharif* crops. Identification of weeds in *kharif* crops. Top dressing and foliar application of fertilizers. Morphological description of *kharif* crops. Yield calculation of *kharif* crops. Visit to experiments at Agronomy farm and research centres.

**Agron. 202 Production Technology for *Rabi* Crops 1+1 Sem. II**

**(For students of B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)**

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *rabi* crops. Cereals - wheat and barley; pulses- chickpea, lentil, peas; oilseeds - rapeseed, mustard and sunflower; sugar crops- sugarcane; medicinal and aromatic crops- lemon grass and citronella; forage crops-*berseem*, lucerne and oat.

**Practical:** Sowing methods of wheat and sugarcane. Identification of weeds in *rabi* season crops. Study of morphological characteristics of *rabi* crops. Study of yield contributing characters of *rabi* season crops and their yield. Study of important agronomic experiments of *rabi* crops at experimental farms. Study of *rabi* forage experiments. Oil extraction of medicinal crops. Visit to research stations of related crops.

**Agron. 203 Farming System and Sustainable Agriculture 1+0 Sem. II**

Farming System-scope, importance, and concept. Types and systems of farming system and factors affecting types of farming. Farming system components and their maintenance. Cropping system and pattern. Multiple cropping system. Efficient cropping system and their evaluation. Allied enterprises and their importance. Tools for determining production and efficiencies in cropping and farming system. Sustainable agriculture-problems and its impact on agriculture. Indicators of sustainability.Adaptation and mitigation. Conservation agriculture strategies in agriculture. HEIA, LEIA and LEISA and its techniques for sustainability. Integrated farming system-historical background, objectives and characteristics. Components of IFS and its advantages. Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques. Resource cycling and flow of energy in different farming system, farming system and environment. Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

**Agron. 206 Weed Management in Horticultural Crops 1+1 Sem.II**

**[For students of B.Sc. (Hons.) Horticulture]**

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed

biology and ecology, crop weed association, crop weed competition and allelopathy. Concepts of weed prevention, control and eradication; Methods of weed control physical, cultural, chemical and biological methods. Integrated weed management; Herbicides advantages and limitation of herbicide usage in India. Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Mode of action of important herbicides, Compatibility of herbicides with other agro chemicals; Weed management in horticultural crops, problematic weeds and their control.

**Practical :** Identification of weeds; survey of weeds in crop fields and other habitats; preparation of herbarium of weeds; methods of recording weed intensity under different situations. Calculations on weed control efficiency and weed index. Herbicide label information; computation of herbicide doses; study of herbicide application equipment and calibration. Demonstration of methods of herbicide application; preparation of list of commonly available herbicides. Study of phytotoxicity symptoms of herbicides in different crops. Economics of weed control practices. Tours and visits of problem areas.

**Agron. 301 Practical Crop Production-I (*Kharif* Crops) 0+2 Sem.I**

**Practical:** Crop planning. Raising field crops in multiple cropping system- field preparation, seed treatment, nursery raising, sowing, nutrient, water, weed, insect-pestand disease management of crops, harvesting, threshing, drying, winnowing, storage and marketing of produce with emphasis on seed production, mechanization, resource conservation and integrated nutrient, weed, insect-pestand disease management technologies. Preparation of balance sheet including cost of cultivation and net returns per student and as well as per team of 8-10 students.

**Agron. 302 Practical Crop Production-II (*Rabi* Crops) 0+2 Sem. II**

**Practical:** Crop planning. Raising field crops in multiple cropping system-field preparation, seed treatment, nursery raising, sowing, nutrient, water, weed, insect-pest and disease management of crops, harvesting, threshing, drying, winnowing, storage and marketing of produce with emphasis on seed production, mechanization, resource conservation and integrated nutrient, weed, insect-pestand disease management technologies. Preparation of balance sheet including cost of cultivation and net returns per student and as well as per team of 8-10 students.

**Agron. 303 Rainfed Agriculture and Watershed Management 1+1 Sem. I**

Rainfed agriculture-introduction and types. History of rainfed agriculture and watershed concept in India. Problems and prospects of rainfed agriculture in India. Soil and climatic conditions in rainfed areas. Drought - types, effect of water deficit on physio-morphological characteristics of the plants.Crop adaptation to drought and mitigation of its effects. Soil and water conservation techniques. Water harvesting– importance and its techniques. Efficient utilization of water through soil and crop management practices**.** Management of crops in rainfed areas**.** Contingent crop planning for aberrant weather conditions. Concept, objectives, principles and components of watershed management. Factors affecting watershed management.

**Practical:** Climate classification. Rainfall pattern in rainfed areas of the country. Pattern of onset and withdrawal of monsoons. Calculations of effective rainfall. Cropping pattern of different rainfed areas in the country and their mapping. Interpretation of meteorological data. Scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Cultural practices for mitigation of moisture stress. Characterization and delineation of model watershed. Field demonstration on soil and moisture conservation measures. Field demonstration of water harvesting structures. Visit to rainfed research station/ watershed.

**Agron. 304 Principles of Organic Farming 1+1 Sem. II**

**[For students of B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Horticulture]**

**(In collaboration with Department of Soil Science, Entomology and Plant Pathology)**

Organic farming - principles and its scope in India. Initiatives taken by Government (central/state),NGOs and other organizations for promotion of organic agriculture. Organic ecosystem and their concepts. Organic nutrient resources and its fortification. Restrictions to nutrient use in organic farming. Choice

of crops and varieties in organic farming. Fundamentals of insect, pest, disease and weed management under organic mode of production. Operational structure of NPOP. Certification process and standards of organic farming. Processing, labelling, economic considerations and viability, marketing and export potential of organic products.

**Practical:** Visit to organic farms for studying various components and their utilization. Preparation and analysis of enriched compost, vermicompost and bio-fertilizers/bio-inoculants. Indigenous Technical Knowledge (ITK) for nutrient, insect, pest, disease and weed management. Cost calculation of organic production systems. Post harvest management- quality aspect, grading, packaging and handling.

**Agron. 305 Weed Management 2+1 Sem. II**

**(Optional course for students of B.Sc. (Hons) Agriculture)**

Weeds - introduction, characteristics and their harmful effects. Classification, reproduction and dissemination of weeds. Herbicide classification. Concept of adjuvant, surfactant, herbicide formulation and their use. Introduction to mode of action of herbicide and selectivity. Allelopathy and its application for weed management. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with agro-chemicals and their application. Integration of herbicides with non-chemical methods of weed management. Herbicide resistance and its management.

**Practical:** Weed identification and techniques of weed preservation. Losses caused by weeds. Biology of important weeds. Study of herbicides– their formulations and mixtures. Shift of weed flora study in long term experiments. Methods of herbicide application. Spraying equipments and their calibration. Calculation of herbicide doses, weed control efficiency and weed index.

**Agron. 306 Sustainable Farming System and Precision Agriculture (2+1) Sem II**

**[For students of B.Sc. (Hons) Agribusiness Management]**

**[In collaboration with Department of Entomology (Theory & Practical) and Punjab Remote Sensing Centre (Practical)]**

Farming system: scope, importance and concept. Types and system of farming system. Factors affecting types of farming system. Farming system components and their maintenance. Cropping system, allied enterprises and their importance. Indicators of sustainability, adaptation and mitigation, determining production and efficiencies in cropping and farming system. Integrated farming system historical background, objectives and characteristics, components of IFS and its advantages, resource use efficiency and optimization techniques. Sustainable agriculture: problems and its impact on Agriculture. Organic farming: Principles and its scope in India; Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts. Organic nutrient resources and its fortification. Restrictions to nutrient use in organic farming. Choice of crops and varieties in organic farming. Fundamentals of insect, pest, disease and weed management under organic mode of production. Operational structure of NPOP; certification process and standards of organic farming. Processing, labeling, economic considerations and viability. Marketing and export potential of organic products. Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture. Global Positioning System (GPS). Geographic Information System (GIS). Site Specific Nutrient Management (SSNM) for nutrient and irrigation management practices. Comparative yield, quality and farm profits under SSNM practices v/s Variable Rate Technology (VRT) practices.

**Practical:** Tools for determining production and efficiencies in cropping and farming system. Visit of cropping systems/IFS models. Organic nutrient resources and its fortification; enriched compost, vermi-compost, liquid organic manures, green manuring, crop residue management, bio-fertilizers/ bio-inoculants and their quality analysis. Pest management under organic production. ITK in organic farming. Processing and labeling of organic products. Economics of organic production system. Visit to organic farms. Use of GPS for agricultural survey & recording observations. Field and area of interest, area estimation, navigation and recording elevation points. Conversion of GPS readings. Study of maps, topo sheets, cartography. Introduction to GIS software, spatial data creation and editing. Introduction to image processing software, visual and digital interpretation of remote sensing images. Generation of spectral profiles of different objects, supervised and unsupervised classification and acreage estimation.

**Agron. 307 Medicinal, Spices and Aromatic Crops** **2+1** **Sem.I**

**(For students of B.Sc. (Hons.) Horticulture)**

History, scope, opportunities and constraints in the cultivation of medicinal, spices and aromatic plants in India and their export potential. Importance, origin, distribution, area, production, climate and soil requirements, propagation and nursery techniques planting and after care, cultural practices, training and pruning, nutritional and water requirements, harvesting, processing and export potential of under mentioned important medicinal, spices and aromatic plants. Chemical composition of a few important medicinal and aromatic plants, extraction, use of essential oils of medicinal and aromatic plants. Role of spice board. Therapeutic and pharmaceutical uses of important spices. Medicinal plants*: Withania*, periwinkle, *Rauvolfia*, dioscorea, *isabgol*, opium, *Ammimajus*, belladonna, cinchoana. Spice Crops: Cardamom, peeper, ginger, turmeric, clove, nutmeg, cinnamon, curry leaf, coriander, fenugreek, fennel, cumin, dillseed, celery and bishops weed. Aromatic plants: citronella, lemon grass, vetiver, lavender, geranium, *patchouli*, mentha and occimum.

**Practical:** Identification and collection of medicinal, spices and aromatic plants from their natural habitat and study their morphological description, nursery techniques, sowing, layout, planting, hoeing, earthing up, training and pruning, harvesting, curing and processing techniques and extraction of essential oils.

**Agron.491 Agro-industrial Attachment: Seed Industries/Herbicide Formulations** **0+4** **Sem. I**

**Agron.492 Experiential Learning in Organic Production Technology** **0+2** **Sem. II**

## Postgraduate Courses

**Agron.-501 Modern Concepts in Crop Production** **3+0** **Sem. I**

**Unit I** Crop growth analysis in relation to environment; Agro- ecological zones of India.

**Unit II** Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

**Unit III** Lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

**Unit IV** Scientific principles of crop production; crop response production functions; concept of soil-plant relations; yield and environmental stress, use of growth hormones and regulators for better adaptation in stressed condition.

**Unit V** Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture. Modern crop production concepts: soil less cultivation, aeroponics, hydroponics, robotics and terrace farming. Use of GIS, GPS and remote sensing in modern agriculture, precision farming and protected agriculture. Agronomic bio-fortification of food crops.

**Agron.-502 Principles and Practices of Soil Fertility and Nutrient Management** **2+1** **Sem. II**

**Unit I** Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

**Unit II** Criteria of essentiality of nutrients. Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

**Unit III** Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management. Soil less cultivation.

**Unit IV** Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency; agronomic, chemical and physiological, fertilizer mixtures and grades; methods of increasing fertilizer use efficiency; nutrient interactions.

**Unit V** Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic nutrients; economics of fertilizer use; integrated nutrient management; use of vermicompost and residue wastes in crops.

**Practical** Determination of soil pH**,** soil EC*,* and soil organic C. Determination of available and total N, P, K and S of soil*.* Determination of total N, P, K, S in plant. Computation of optimum and economic yield.

**Agron.-503 Principles and Practices of Weed Management 2+1 Sem. I**

**Unit I** Weed biology, and ecology and classification, crop-weed competition including allelopathy; principles and methods of weed control and classification management; weed indices, weed shift in different eco-systems.

**Unit II** Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

**Unit III** Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures, sequential application of herbicides, rotation; weed control through use of nano-herbicides and bio-herbicides, myco- herbicides bioagents, and allelochemicals; movement of herbicides in soil and plant. Degradation of herbicides in soil and plants; herbicide resistance, residue, persistence and management; development of herbicide resistance in weeds and crops and their management, herbicide combination and rotation.

**Unit IV** Weed management in major crops and cropping systems; alien, invasive and parasitic weeds and their management; weed shifts in cropping systems; aquatic and perennial weed control; weed control in non-crop area.

**Unit V** Integrated weed management; recent development in weed management- robotics, use of drones and aeroplanes, organic etc., cost:benefit analysis of weed management.

**Practical :** Identification of important weeds of different crops. Preparation of a weed herbarium. Weed survey in crops and cropping systems. Crop-weed competition studies, weed indices calculation and interpretation with data. Preparation of spray solutions of herbicides for high and low-volume sprayers, use of various types of spray pumps and nozzles and calculation of swath width. Economics of weed control. Herbicide resistance analysis in plant and soil. Bioassay of herbicide resistance residues. Calculation of herbicide requirement.

**Agron.-504 Principles and Practices of Water Management 2+1 Sem.I**

**Unit I** Water and its role in plants; Irrigation: Definition and objectives, water resources and irrigation development in India and concerned state, major irrigation projects, extent of area and crops irrigated in India and in different states.

**Unit II** Field water cycle, water movement in soil and plants; transpiration; soil-water-plantrelationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition. Determination of hydraulic conductivity of saturated soil below the water table by auger hole method. Estimation of upward flux of water using tensiometer and from depth ground water table. Water availability and its relationship with nutrient availability and loses.

**Unit III** Soil, plant and meteorological factors determining water needs of crops, scheduling, depth and methods of irrigation; micro irrigation systems; deficit irrigation; fertigation; management of water in controlled environments and polyhouses. Irrigation efficiency and water use efficiency.

**Unit IV** Water management of crop and cropping system, Crop water requirement estimation of ET and effective rainfall; automated irrigation system and use of Internet of things (IoT) in water management.

**Unit V** Excess of soil water and plant growth; water management in problem soils, drainagerequirement of crops and methods of field drainage, their layout and spacing; rain water management and its utilization for crop production.

**Unit VI** Quality of irrigation water and management of saline water for irrigation, watermanagement in problem soils

**Unit VII** Soil moisture conservation, water harvesting, rain water management and its utilization for crop production.

**Unit VIII** Hydroponics and aeroponics.

**Unit IX** Water management of crops under climate change scenario.

**Practical :** Determination of field capacity by field method and permanent wilting point by sunflower pot culture technique. Determination of field capacity and permanent wilting point by Pressure Plate Apparatus. Determination of hygroscopic coefficient, maximum water holding capacity of soil and soil-moisture characteristics curves. Measurement of matric potential using gauge and mercury type tensiometer. Determination of saturated hydraulic conductivity by constant and falling head method. Measurement of soil water diffusivity. Estimation of unsaturated hydraulic conductivity. Determination of irrigation requirement of crops (calculations) and effective rainfall (calculations). Determination of ET of crops by soil moisture depletion method. Determination of water requirements of crops. Measurement of irrigation water by volume and velocity-area method. Measurement of irrigation water by measuring devices and calculation of irrigation efficiency. Determination of infiltration rate by double ring infiltrometer.

**Agron.-505 Conservation Agriculture 1+1 Sem.II**

**Unit I** Conventional and Conservation Agriculture (CA) systems, sustainability concerns, conservation agriculture. Historical background and present concept, global experiences, present status in India.

**Unit II** Nutrient management in CA, water management, weed management, energy use, insect-pest and disease management, farm machinery, crop residue management, cover crop management.

**Unit III** Climate change mitigation and CA, C-sequestration, soil health management, soil microbes and CA.

**Unit IV** CA in agroforestry systems, rainfed / dryland regions.

**Unit V** Economic considerations in CA, adoption and constraints, CA: The future of agriculture.

**Practical :** Study of long-term experiments on CA, evaluation of soil health parameters, estimation of C-sequestration, machinery calibration for sowing different crops, weed seed bank, estimation under CA, energy requirements, economic analysis of CA.

**Agron.-506 Agronomy of Major Cereals and Pulses 1+1 Sem. II**

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of

**Unit I** *Rabi* cereals – wheat, barley, oats.

**Unit II** *Kharif* cereals – rice, maize, sorghum.

**Unit III** *Rabi* pulses – gram, lentil

**Unit IV** *Kharif* pulses - pigeonpea, moongbean, urdbean.

**Practical :** Phenological studies at different growth stages of crop. Estimation of crop yield on the basis of yield attributes. Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities. Working out growth indices (CGR, RGR, NAR, LAI, LAD, LAR, LWR, SLA, SLW etc). Assessment of land use and yield advantage (rotational intensity, cropping intensity, diversity index, sustainable yield index, crop equivalent yield, land equivalent ratio, aggressiveness, relative crowding coefficient, competition ratio and ATER etc). Estimation of protein content in pulses. Planning and layout of field experiments. Judging of physiological maturity in different crops. Intercultural operations in different crops. Determination of cost of cultivation of different crops. Working out harvest index of various crops. Study of seed production techniques in selected crops. Visit of field experiments on cultural, fertilizer, weed control and water management aspects. Visit to nearby villages for identification of constraints in crop production.

**Agron.-507 Agronomy of Oilseed, Fibre and Sugar Crops 2+1 Sem.I**

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality component, handling and processing of the produce for maximum production of

**Unit I** *Rabi* oilseeds – rapeseed and mustard, linseed and safflower.

**Unit II** *Kharif* oilseeds - groundnut, sesame, castor, sunflower, soybean and niger.

**Unit III** Fiber crops - cotton, jute, ramie and mesta.

**Unit IV** Sugar crops – sugar-beet and sugarcane.

**Practical :** Planning and layout of field experiments. Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane. Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice phenological studies at different growth stages of crop. Intercultural operations in different crops. Cotton seed treatment. Working out growth indices (CGR, RGR, NAR, LAI, LAD, LAR, LWR, SLA, SLW etc). Assessment of land use and yield advantage (rotational intensity, cropping intensity, diversity index, sustainable yield index, crop equivalent yield, land equivalent ration, aggressiveness, relative crowding coefficient, competition ratio and ATER etc). Judging of physiological maturity in different crops and working out harvest index. Working out cost of cultivation of different crops. Estimation of crop yield on the basis of yield attributes. Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities. Determination of oil content in oilseeds and computation of oil yield. Estimation of quality of fibre of different fibre crops. Study of seed production techniques in various crops. Visit of field experiments on cultural, fertilizer, weed control and water management. Visit to nearby villages for identification of constraints in crop production.

**Agron.-508 Agronomy of Medicinal, Aromatic and Underutilized Crops 2+1 Sem.I**

**Unit I** Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and their uses, export potential and indigenous technical knowledge.

**Unit II** Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (*mulhati*, *isabgol*, rauwolfia, poppy, Aloe vera, *satavar*, stevia, *safedmusli*, kalmegh, asaphoetida, nuxvomica, etc).

**Unit III** Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (*Citronella*, palmarosa, *Mentha*, basil, lemon grass, rose, *patchouli*, *Geranium*).

**Unit IV** Climate and soil requirements; cultural practices; yield of under-utilized crops (rice bean, *Lathyrus*, *Sesbania*, clusterbean, French bean, fenugreek, grain amaranth, Celery.

**Unit V** Post harvest handling –drawing, processing, grading, packing and storage, value addition and quality standards in herbal products.

**Practical :** Identification of crops based on morphological and seed characteristics. Raising of herbarium of medicinal, aromatic and under-utilized plants. Quality charactersin medicinal and aromatic plants. Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants.

**Agron.-509 Agronomy of Fodder and Forage Crops 2+1 Sem.II**

**Unit I** Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like sorghum, maize, *bajra*, *guar*, cowpea, oats, barley, berseem, *senji*, lucerne etc.

**Unit II** Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses lime, Napier grass, *Panicum*, *Lasiuras*, *Cenchrus* etc.

**Unit III** Year-round fodder production and management, preservation and utilization of forage and pasture crops.

**Unit IV** Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition; value addition of poor quality fodder. Fodder production through hydroponics. Azolla cultivation.

**Unit V** Economics of forage cultivation uses and seed production techniques of important fodder crops.

**Practical :** Practical training of farm operations in raising fodder crops. Canopy measurement, yield, Leaf Stem ratio and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose and IVDMD etc. of various fodder and forage crops. Anti-quality components like HCN in sorghum and such factors in other crops. Hay and silage making and economics of their preparation.

**Agron.-510 Agrostology and Agro-Forestry 2+1 Sem. I**

**Unit I** Agrostology: definition and importance; principles of grassland ecology: grassland ecology – community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands.

**Unit II** Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation-natural pastures, cultivated pastures; common pasture grasses.

**Unit III** Agroforestry: definition and importance; agroforestory systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aqua silviculture, alley cropping and energy plantation.

**Unit IV** Crop production technology in agro-forestory and agrostology system; silvipastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestrysystems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.

**Practical :** Preparation of charts and maps of India showing different types of pastures and agro-forestry systems. Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry. Seed treatment for better germination of farm vegetation. Methods of propagation/planting of grasses and trees in silvipastoral system. Fertilizer application in strip and silvipastroal systems. After-care of plantation. Estimation of protein content in loppings of important fodder trees. Estimation of calorie value of wood of important fuel trees. Estimation of total biomass and fuel wood. Economics of agro-forestry. Visit to important agro-forestry and farm forestry sites.

**Agron.-511 Cropping Systems and Sustainable Agriculture 2+0 Sem.II**

**Unit I** Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

**Unit II** Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

**Unit III** Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

**Unit IV** Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Advanced nutritional tools for big data analysis and interpretation.

**Unit V** Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

**Unit VI** Artificial Intelligence- concept and application.

**Agron.-512 Dryland Farming and Watershed Management 2+1 Sem.II**

**Unit I** Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

**Unit II** Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

**Unit III** Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

**Unit IV** Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transpirants; soil and crop management techniques, seeding and efficient fertilizer use.

**Unit V** Concept of watershed resource management, problems, approach and components.

**Practical :** Method of Seed Priming. Determination of moisture content of germination of important dryland crops. Determination of Relative Water Content and Saturation Deficit of Leaf. Moisture stress effects and recovery behaviour of important crops. Estimation of Potential ET by Thornthwaite method. Estimation of Reference ET by Penman Monteith Method. Classification of climate by Thornthwaite method (based on moisture index, humidity index and aridity index). Classification of climate by Koppen Method. Estimation of water balance by Thornthwaite method. Estimation of water balance by FAO method. Assessment of drought. Estimation of length of growing period. Estimation of probability of rain and crop planning for different drought condition. Spray of anti-transpirants and their effect on crops. Water use efficiency. Visit to dryland research stations and watershed projects.

**Agron.-513 Principles and Practices of Organic Farming 2+0 Sem.II**

**Unit I** Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; principles of organic agriculture; standards of organic farming, organic farming v/s natural farming and sustainable agriculture; selection and conversion of land, soil and water management - land use, conservation tillage; shelter zones, hedges, pasture management, agro-forestry.

**Unit II** Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures, bio-fertilizers and biogas technology,

**Unit III** Farming systems, selection of crops and crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity. Integrated organic farming systems and organic IFS models.

**Unit IV** Control of weeds, diseases and insect pest management, biological agents and pheromones, bio-pesticides.

**Unit V** Socio-economic impacts; marketing and export potential inspection, certification, labeling and accreditation procedures; organic farming and national economy.

**Practical :** Method of making compost by aerobic and anaerobic method. Method of making vermicompost. Identification and nursery raising of important agro-forestry tress and tress for shelter Belts. Efficient use of biofertilizers, technique of treating legume seeds with Rhizobium cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field. Visit to a biogas plant. Visit to an organic farm. Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms.

**Agron.-514 Field Plot Techniques 1+1 Sem.II**

**Unit I** Field plot experimentation: Principles. Planning field experiments-objectives, selection of field and treatments. Efficient conduct of the experiments. Recording biometrical observations. Sources of error in the field experiments and methods of reducing it.

**Unit II** Selection of experimental designs. Commonly used designs in field experiments; CRD, RCBD, LSD, Split-plot, Strip-plot Factorial experiments and interaction effects. Experiments to study the effect of years and locations.

**Unit III** Compilation, presentation and interpretation of the data. Different tests of significance. Correlation and response functions. Transformation of data.

**Practical** Actual layout of field experiments. Data analysis of different experiment designs; CRD, RCBD, LSD, Split-plot, Strip-plot. Critical examination of experiments scientific journals. Compilation and interpretation of the given data. Missing plots and analysis of variance results. Use of computers for analysis of data.

**Agron.-591 Seminar** **1+0**

**Agron.-599 Master's Research** **0+30**

**Ph.D. courses**

**Agron.-601 Current Trends in Agronomy** **3+0** **Sem.II**

**Unit I** Agro-physiological basis of variation in yield, recent advances in soil plant-waterrelationship.

**Unit II** Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures and ITK in organic farming.

**Unit III** Crop residue management in multiple cropping systems; latest developments in plant management. Mechanization in crop production: modern agricultural precision tools and technologies, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

**Unit IV** GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

**Unit V** Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy. Conservation agriculture, principles, prospects and importance, potential benefits of CA under climate change scenario, policy issues.

**Agron.-602 Recent Trends in Crop Growth and Productivity** **2+1** **Sem.I**

**Unit I** Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

**Unit II** Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

**Unit III** Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity concept and types of heat units.

**Unit IV** Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

**Practical :** Field measurement of root-shoot relationship in crops at different growth stages. Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth. Computation of harvest index of various crops. Assessment of crop yield on the basis of yield attributing characters. Construction of crop growth curves based on growth analysis data. Computation of competition

functions, viz. LER, IER aggressivity competition index etc in intercropping. Senescence and abscission indices. Analysis of productivity trend in un-irrigated areas. Analysis of productivity trend in irrigated areas.

**Agron.-603 Irrigation Management** **2+1** **Sem.II**

**Unit I** Global water resources; Water resources of India, irrigation projects during pre and post-independence period and their significance in crop production.

**Unit II** Movement of water in soil-water movement under saturated and unsaturated conditions, Poiseulle's and Darcy's law, general equation of saturated and unsaturatedflow of water in soil. Physiological processes and crop productivity.

**Unit III** Water requirement, irrigation needs, factors affecting irrigation need; water use efficiency, Infiltration; management practices for improving water use efficiency of crops.

**Unit IV** Soil and plant water potential, SPAC, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, factors affecting ET, control of ETby mulching and use of anti-transpirants; fertilizer use in relation to irrigation.

**Unit V** Crop water stress – water deficits and crop growth, adoptability to the crops. Water availability with relation to nutrient availability.

**Unit VI** Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

**Unit VII** Strategies of using limited water supply; optimizing the use of given irrigation supplies.

**Unit VIII** Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

**Unit IX** Economic analysis of irrigation and cop planning for optimum use of irrigation water. **Unit X** Crop water production function.

**Practical :** Determination of water infiltration characteristics and water holding capacity of soil profiles. Determination Moisture extraction pattern of crops. Determination of water balance component of transplanted rice by drum culture technique. Determination of consumptive use and water requirement of a given cropping pattern. Determination of crop coefficient of one important crop. Planning, designing and installation of drip and sprinkler irrigation system. Designing of drainage channel. Measurement of irrigation efficiencies. Determination of irrigation timing under different methods of irrigation. Visit to irrigation command area.

**Agron.-604 Recent Trends in Weed Management** **2+0** **Sem.II**

**Unit I** Crop-weed competition in different cropping situations; changes in weed flora, various causes and effects; different methods of weed management. Migration, introduction, adaptation of weeds, Invasive weeds – biology and management. Different mechanisms of invasion – present status and factors influencing weed invasion.

**Unit II** Physiological and biological aspects of herbicides, their absorption, translocation,metabolism and mode of action; selectivity of herbicides and factors affecting them.

**Unit III** Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, Degradation of herbicides in soil and plants- factors affecting it, primary and secondary metabolites, residue management of herbicides, adjuvants.

**Unit IV** Advances in herbicide products and application techniques and methods; herbicideresistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides; herbicide rotation and herbicide mixtures. Unit V Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

**Unit VI** Relationship of herbicides with tillage, fertilizer, and irrigation, cropping system;bioherbicides, allelochemical and allele herbicides, herbicide bioassays. Recent advances in nonchemical weed management including deleterious rhizobacteria, robotics, biodegradable film etc.

**Agron.-605 Integrated Farming Systems for Sustainable Agriculture 2+0 Sem. I**

**Unit I** Integrated Farming Systems (IFS): definition, scope and importance; classification ofIFS based on enterprises as well as under rainfed/irrigated condition in different land situation. Farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises. Bankable IFS models, farming systemtypology analysis, value chain analysis, farming system study using farm design software.

**Unit II** Concept of sustainability in of Integrated farming systems; efficient Integratedfarming systems based on economic viability and natural resources - identification and management.

**Unit III** Production potential of different components of Integrated farming systems; interaction and mechanism of different production factors; stability of Integrated Farming system based on research/long term information in different systems through research; eco-physiological approaches to intercropping. Integration of components and adaptability of different farming system based on land situations and climatic condition of a region; evaluation of IFS.

**Unit IV** Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems. Formationof different Integrated Farming system Models; evaluation of different Integrated Farming system models. Recycling of organic waste in farming system, in IFS.

**Unit V** New concepts and approaches of farming system and organic farming; value addition, waste recycling, quantification and mitigation of Green House gases; case studies/ success stories of different Integrated Farming systems. cropping systems and organic farming; case studies on different farming systems. Possible use of ITK in Integratedfarming system.

**Agron.-606 Soil Conservation and Watershed Management 2+1 Sem.I**

**Unit I** Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

**Unit II** Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; mulching, tillage, cropping system vegetative barriers; improved dry farming practices; mechanical measures - bunding,gully control, bench terracing; role of grasses and pastures in soil conservation; windbreaks and shelter belts.

**Unit III** Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

**Unit IV** Land use capability classification, alternate land use systems; agroforestry; leyfarming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

**Unit V** Drainage, methods of drainage, Drainage considerations and agronomic management; rehabilitation of abandoned *jhum* lands and measures to prevent soil erosion.

**Practical :** Study of different types of erosion. Determination of dispersion ratio. Estimationof soil loss by Universal Soil Loss Equation and by wind erosion. Measurement of runoff and soil loss. Field studies of different soil conservation measures. Laying outrun-off plot and deciding treatments. Identification of different grasses and treesfor soil conservation. Visit to watershed areas, soil conservation research centre, demonstration and training centre.

**Agron.-607 Stress Crop Production 2+1 Sem.II**

(**Practical - In collaboration with Department of Botany)**

**Unit I** Stress and strain terminology; nature and stress injury and resistance; causes ofstress.

**Unit II** Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, Practical to overcome theeffect of low temperature tress through, soil and crop manipulations.

**Unit III** High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, **Practical** ways to overcome the effect of heat stress through soil and crop manipulations.

**Unit IV** Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, Practical ways to overcome effect of water deficit stress through soil and crop, manipulations.

**Unit V** Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, Practical ways to overcome excess water stress through soil and crop manipulations.

**Unit VI** Salt stress: meaning of salt stress and its effect on crop growth, salt stress and resistance in plants, Practical ways to overcome the effect of salt stress through soil and crop manipulations.

**Unit VII** Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.

**Unit VIII** Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

**Practical :** Determination of electrical conductivity of plant cell sap. Determination of osmotic potential and tissue water potential. Measurement of transpiration rate and stomatal frequency. Measurement of relative water content of leaf. Measurement of electrolytic leakage. Growing of plants in sand culture under salt stress for biochemical and physiological studies. Studies on effect of osmotic and ionic stress on seed germination and seedling growth. Measurement of low temperature injury under field conditions. Studies on plant responses to excess water.

**Agron.-691 Seminar I** **1+0**

**Agron.-692 Seminar II** **1+0**

**Agron.-699 Ph.D. Research** **0+75**

# ANIMAL SCIENCE

## Diploma course

**LPM 51 Elementary Livestock and Poultry Production** **3+1** **Sem. II**

Importance of livestock and livestock farming. Important breeds of cattle, buffaloes, sheep, goat, swine and poultry. Judging. Selection and breeding of livestock for genetic improvement. Reproduction, reproductive behavior, estrous cycle, detection of estrous. Artificial insemination. Livestock feeding and ration formulation. Silage and hay making. Housing. Factors affecting milk yield and composition. Clean milk production. Care of young ones and adult animals. Composition and formation ofan egg. Care and incubation of the eggs. Grading of eggs. Hatchery management. Preparing the animals for marketing. Transportation of animals. Common diseases, their prevention and control. Economics of livestock and poultry enterprises. Livestock development programmes of Govt. of India and State Govt.

**Practical:** Handling of various categories of livestock. Breed of livestock and poultry. Methods of restraint. External body parts of animals. Judging of animals. Milking. Feed formulation and mixing of concentrate. Management of young ones - feeding, tattooing and dehorning. Recording of body weight, temperature, and pulses and respiration rates. Study of reproductive organs. Artificial insemination. Cleaningand disinfection of houses. Selection and incubation of hatching eggs. Grading and handling of eggs. Visit to various livestock farms.

## Undergraduate Courses

**AS 201 Livestock and Poultry Management** **2+1** **Sem. I / II**

**(For students of B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)**

Livestock history in India Vedic, medieval and modern era. Demographic distribution of livestock and role in economy. Introductory animal husbandry. Breeds of livestock. Cattle, Buffalo, Sheep, Goat and Pig. Important traits of livestock. General management and feeding practices of animals. Handling and restraining of animals. Housing systems. Importance of grasslands and fodders in livestock production. Common farm management practices including disinfection, isolation, quarantine and disposal of carcass. Common vices of animals and their prevention. Diseases and parasite control & hygiene care. History and economic importance of poultry. Poultry breeds. Reproductive system of male and female birds. Formation and structureof eggs. Important economic traits of poultry. Egg production, Egg weight, Egg quality. Fertility and hatchability. Plumage characteristics and comb types. Care andmanagement of chicks, grower and layers/broiler. Brooding management. Hatchery practices. Poultry diseases, control and hygiene care. Importance, advantages and limiting factors in fish farming. Common terms and species of fish. Scientific fish farming. Important diseases of fish along with their preventive measures.

**Practical:** Visit to livestock farms/demonstration centres. Breeds of cattle, buffalo, sheep, goat and Pigs. Familiarization with body parts of animals. Handling and restraining of cattle, buffalo, sheep, goat and swine. Male and female reproductive system and Artificial Insemination. Feeding of livestock. Methods of identification, marking, tattooing, branding and tagging. Milking methods. Record Keeping. Visit to the Poultry farm. Poultry breeds. Body parts of chicken, duck, quail and turkey. Housing, equipments, nesting and brooding requirements. Male and female reproductive system. Methods of identification and sexing. Hatchery layout and equipment. Identification of diseases and control of parasites. Vaccination. Maintenance of farm records. Fisheries: Pond designs and their management. Identification and management of different types offish. Water and soil quality parameters for fish ponds.

**AS 202 Livestock, Poultry and Fish Production Management** **1+1** **Sem. I**

**[For students of B.Sc. (Hons.) Agribusiness Management]**

Role of livestock and poultry in the national economy. Important Indian and exotic breeds of cattle, buffalo, sheep, goat and poultry. Housing; principles, space requirements for different species of livestock and poultry. Feeding and ration formulations ingredients. Feed supplements and feed additives for livestock and poultry ration. Preparation of concentrate mixture. Fodder conservation and preservation, enrichment

of fodder. Reproduction in farm animals and poultry. Artificial insemination. and its importance. Feeding and management of calves, heifers, pregnant and milch animals. Physiology of lactation; physical and chemical properties of Milk, clean milk production. Breeds of poultry. Incubation, hatching and brooding in poultry. Management of broilers, growers, layers and backyard birds. Management of sheep and Goats. Prevention, vaccination schedule and control of important diseases of livestock and poultry. Marketing and economics of livestock and poultry. Fisheries resources of India and importance of inland fisheries Commercial cultivation, important fishes and their production.

**Practical:** Introduction to university livestock farms. and common terminologies of animal sciences. Study of external body parts of livestock. Study of different breeds of Indian and Exotic livestock. Study of housing for livestock. Handling and restraining of animals. Estimation of age of animals. Methods of identification of animals. Judging and cullingof animals. Feed Ingredients and ration formulations. Study of reproductive system of livestock. Artificial insemination in dairy animals. Physiology of lactation; physical and chemical properties of milk, clean milk production and milking methods in dairy animals. Estimation of specific gravity of milk. Quality parameter analysis of Milk. Estimation of Fat of milk. Estimation of total solids and SNF of milk. Estimation of milk adulterants and Preservatives. Study of reproductive system of hen, formation of egg, egg structure and chemical composition. Study of common feeds and fodder. Conservation of Fodder and computation of ration for livestock. Common equipment used in livestock farms. Importance of Records in Livestock. Visit to Fish ponds to study fish production. Economics of Livestock, Poultry and Fishery Units.

# MOLECULAR BIOLOGY AND BIOTECHNOLOGY

## PROGRAMMES

**M.Sc. Molecular Biology and Biotechnology**

**Ph.D. Molecular Biology and Biotechnology**

## COURSE REQUIREMENT

### M.Sc.

| | |
|---|---|
| Field of Specialization | Molecular Biology |
| Core Courses | MBB-502, MBB-504, MBB-506, MBB-508, MBB-509 |
| Minor Fields | Biochemistry, Genetics and Plant Breeding, Microbiology, Plant Pathology, Entomology, Fruit Science, Vegetable Science, Floriculture and Landscaping, Forestry or any other related discipline as approved by Dean, Postgraduate Studies |
| Supporting Courses | Stat.-502, and courses from subject matter fields (other than Minor) relating to area of special interest and research problems. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Plant Molecular Biology and Plant Genome Engineering |
| Core Courses | MBB-601, MBB-602* |
| Minor Fields | Biochemistry, Genetics & Plant Breeding, Microbiology, Plant Pathology, Entomology, Fruit Science, Vegetable Science, Floriculture and Landscaping, Forestry or any other related discipline as approved by Dean, Postgraduate Studies |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problems. |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**Biotech. 101 Cell Biology 2+0 Sem. I**

Origin and evolution of cell. Introduction to microscopy. Sub-cellular structure of prokaryotic and eukaryotic cells. Membrane structure and function: plasma membrane, cell wall and extracellular matrix. Structural organization and function of intracellular organelles and organelle biogenesis. Nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles. Structure and function of cytoskeleton and its role in motility. Cell membrane transport. Introduction to cell signalling. Cell growth, cell cycle and its control. Cell death and cell renewal.

**Biotech. 102 Molecular Biology 2+1 Sem. II**

History of molecular biology. Central dogma of life. Structure of DNA and RNA. Gene structure and function. DNA replication. Transcription. Genetic code and translation. Structure of prokaryotic and eukaryotic nuclear and organelle genomes. Gene regulation in prokaryotes: Lac operon concept, Tryp concept, Introduction to microbial genetics. Conjugation, transformation and transduction. Tools in molecular biology. Role of enzymes in molecular biology. Principles of Polymerase Chain Reaction. Electrophoresis. PCR and hybridization based molecular markers.

**Practical:** Preparation of bacterial competent cells and transformation. Isolation and purification ofplant and animal DNA. Measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis. DNA amplification using RAPD, microsatellite primers and analysis. CAPS primers. Generation of linkage maps and mapping of qualitative genes. Estimation of genetic similarities andgeneration of dendrograms.

**Biotech. 103 Introduction to Biotechnology 2+1 Sem. I**

History, definitions, concepts, scope and importance of Biotechnology - plant, microbial, animal, medical, environmental, industrial, marine, agricultural and food biotechnology. Nano biotechnology. Introduction to recombinant DNA technology and its applications-vectors, DNA restriction and modifying enzymes, gene cloning. Introduction to genomics and proteomics: Molecular markers, DNA sequencing. Genetic transformation and transgenic organisms. Bioinformatics. Biosafety guidelines.

**Practical:** Orientation to the laboratories: glass houses, screen houses, transgenic facilities and field area. General guidelines for working in biotechnology laboratory. Familiarization with basic equipment used in biotechnology. Selection of chemicals (different grade), buffer preparation, calculations and scientific notations used in laboratories.

**Biotech. 104 Plant Tissue Culture 2+1 Sem. II**

History of plant tissue culture. Concept of totipotency. Concept of aseptic culture practices. Components of *in vitro* culture media and role of different macro and micro nutrients, vitamins, plant growth regulators and growth supplements. Sterilization techniques. Various pant cell, tissue and organ culture techniques and uses. Somatic cell cultures. Morphogenesis - organogenesis and somatic embryogenesis. Micropropagation - *in vito* grafting, meristem culture. Anther, pollen, embryo, ovule, ovary culture. Protoplast culture and somatic hybridization. Somaclonal variation.

**Practical:** Good laboratory practices. Media preparation and sterilization. Surface sterilization of explants. Establishment of callus/ cell suspension cultures. Micropropagation. Embryo culture. Anther and pollen culture. Induction of plant regeneration. Hardening and transfer to soil.

**Biotech. 106 Electronics and Instrumentation in Biotechnology 1+1 Sem. II**

Electronics, PN junction diode, diode forward and reverse characteristics. Diode as circuit element. Application of junction diode - half wave, full wave bridge rectifier, clipper, clamper, voltage multiplier circuit. Construction and working of bipolar transistor, load line concept, design of biasing methods of NPN transistor, AC model, analysis of small signal NPN transistor. Concept of instrumentation system. Transducers for temperature measurement, linear displacement measurement using LVDT. Force measurement

using strain gauge. Principles, working of table top, refrigerated and ultra- centrifuges, laminar air flow, autoclaves, pH meter, fermenters, temperature control and BOD shakers, gel electrophoresis, 2-D gel electrophoresis, gel documentation, gel driers, ELISA readers, lypholizers, spectrophotometers, gene pulser, particle gun, growth chambers, thermal cyclers, Real time PCR, DNA synthesizer and sequencer. Microscopes.

**Practical:** Familiarization with laboratory equipment and equipment working. Forward and reverse characteristics of a PN junction diode. Study of half wave, full wave, bridge rectifier using diode. Clipper, clamper and voltage multiplier circuit. Determination of input V-I characteristics of bipolar transistor for common emitter configuration. Determination of output V-I characteristics of bipolar transistor for common emitter configuration. Analysis of a biasing circuit for CE transistor. Design and test a biasing circuit for CE transistor. Study the measure of temperature using available sensor. Measurement of displacement with the available sensor. Study force with the available sensor.

**Biotech. 202 Introductory Bioinformatics 2+1 Sem. I**

Introduction to bioinformatics. Development and scope of bioinformatics. Applications of computers in bioinformatics. Operating systems, hardware, software, Internet, world wide web resources and FTP. Primary databases - nucleotide sequence databases (GenBank, EMBL), protein sequence databases. Secondary databases - SwissProt/TrEMBL, conserved domain database, Pfam. Structure databases - Protein Data Bank (PDB), MMDB, SCOP, CATH. File formats - Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML. Introduction to sequence alignment and its applications - pair wise and multiple sequence alignment, concept of local and global alignment. Algorithms - Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman). Tools of MSA-ClustalW, TCoffee. Phylogeny. Introduction to BLAST and FASTA.

**Practical:** Basic computing - Introduction to UNIX, LINUX. Nucleotide information resource - EMBL, GenBank, DDBJ, Unigene. Protein information resource - SwissProt, TrEMBL, Uniprot. Structure databases - PDB, MMDB. Search engines - Entrez, ARSA, SRS. Similarity searching - BLAST and interpreting results. Multiple sequence alignment - ClustalW. Structure visualization of DNA and proteins using Rasmol.

**Biotech. 201 Recombinant DNA Technology 2+1 Sem. II**

Recombinant DNA technology. Restriction endonucleases - types and uses. DNA ligases. Vectors plasmids, cosmids, phagemids, bacterial artificial chromosomes (BACs), P1-derived artificial chromosomes (PACs), yeast artificial chromosomes (YACs), transposon vectors, expression vectors, shuttle vectors, binary plant vectors, co-integrating vectors. Construction and applications of chimeric DNA, Competent cells. Gene isolation and cloning. Genetic transformation of *E. coli*. Gel electrophoresis. Preparation of probes. Southern blotting. Northern blotting. Western blotting. PCR and *in vitro* gene amplification.

**Practical:** Orientation to recombinant DNA lab. Preparation of stock solutions and buffers. Plasmid DNA isolation. Genomic DNA isolation. Quality and quantity determination of DNA. Restriction digestion of DNA. Agarose gel electrophoresis, SDS-PAGE. PCR. Genetic transformation of *E. coli*. Screening of recombinant DNA clones in *E. coli*.

**Biotech. 203 Plant Genetic Transformation 2+1 Sem. II**

History of plant genetic transformation. Generation of gene construct and maintenance. Methods of genetic transformation - *Agrobacterium* mediated, biolistics, electroporation, liposome, Polyethylene glycol, *In planta* methods. Selection and characterization of transgenic plants using selectable and reportable markers. PCR, qRT-PCR, Southern, Northern, ELISA and Western techniques. Application of genetic transformation for developing transgenics for quality, yield, biotic and abiotic stresses. Biosafety aspects of transgenic plants and regulatory framework.

**Practical:** Preparation of stock solutions and buffers for genetic transformation. Preparation of competent cells of *Agrobacterium tumefaciens*. Restriction mapping of plasmid. Construction of binary vector and its transfer to an *Agrobacterium* strain. Confirmation of transformed bacterial colonies. *Agrobacterium tumefaciens* mediated and biolistic plant transformation. Colony hybridization.

**Biotech. 204 Classical and Molecular Cytogenetics 2+1 Sem. II**

Introduction and history. Mitosis and meiosis. Structure of chromatin. Chromosome structure and chromosome landmarks. Specialized chromosomes. Differential staining of the chromosomes Q-banding, G-banding, C-banding and R banding. *In situ* hybridization - FISH, GISH. Changes in chromosome number. Aneuploidy - monosomy, trisomy and tetrasomy. Haploidy. Polyploidy - autopolyploidy and allopolyploidy. Methods of doubled haploid production. Structural aberrations of chromosomes - deletions, duplications, inversions and translocations. Locating genes on chromosomes. Genome analysis.

**Practical:** Preparation of chromosome stains. Testing of pollen fertility. Preparation of mitotic and meiotic slides of onion, pearl millet, wheat etc. Preparation of karyotypes. C/G banding of the chromosomes. Genomic *in situ* hybridization. Microphotography.

**Biotech. 206 Fundamentals of Plant Biotechnology 2+1 Sem. II**

**[For students of B.Sc. (Hons.) Agriculture]**

Concepts and history. Various aspects of plant tissue culture. Somatic embryogenesis. Meristem culture. Micropropagation. Somaclonal variation. Anther and pollen culture. Embryo/ovule/ ovary and endosperm culture. Protoplast culture and somatic hybridization. Cryopreservation of germplasm. Recombinant DNA technology. Gene cloning approaches. Methods of Genetic Transformation. Genetic Engineering. Southern, Northern and Western Hybridization. Polymerase Chain Reaction and its variants. Hybridization and PCR based DNA markers. Gene and QTL mapping. Marker assisted selection for precision plant breeding. Examples of marker assisted selection in commercial agriculture. Introduction to bioinformatics.

**Practical:** Culture media preparation. Surface sterilization of explants. Establishment of callus/cell suspension cultures. Induction of plant regeneration. Hardening and transfer to soil. Micropropagation. Embryo culture. Demonstration of gene transfer techniques. Isolation of plant DNA. Measurement of nucleic acids concentration using photo spectrometer and gel electrophoresis. PCR. DNA amplification using microsatellite primers and its fractionation using agarose gels. Introduction to various databases.

**Biotech. 208 Introduction to Plant Biotechnology for Agribusiness 2+0 Sem. II**

**[For students of B.Sc. (Hons.) Agribusiness Management]**

Introduction to various aspects of plant biotechnology. Recombinant DNA technology, common enzymes used in molecular tools. Vectors, gene cloning. Introduction to marker assisted breeding in crop improvement. Molecular markers and their applications. Commercial utilization of genetically modified and gene edited crops. Business side of molecular biology. Industrial units providing Biotech services for oligosynthesis, production of restriction enzymes, Taq polymerase, DNA sequencing, GWAS, data analysis. Production of tissue culture plants. Entrepreneurial skill development by educational institutions for establishing molecular biology unit and tissue culture unit.

**Biotech. 301 Molecular Genetics 2+0 Sem. I**

Structures, properties and modifications of DNA. Molecular mechanism of DNA replication, repair, mutation and recombination. Centromere and telomere sequences and DNA packaging. Synthesis and processing of RNA and proteins. Regulation of gene expression. Mutations and DNA repair. Repetitive DNA sequences and transposable elements. Promoters and their isolation. Transcription factors – their classification and role in gene expression. Epigenetic control of gene expression. Small RNAs, RNA interference and its applications.

**Biotech. 302 Nanobiotechnology 2+0 Sem. I**

Introduction to nanotechnology. Concepts and terminology. Types of nanomaterials and their synthesis approaches. Nano-bio interface. Factors affecting interactions at the nano-bio interface. Biological based nanosystems, molecular motors and their types, biosensors and other devices, applications of biosensors in agriculture. Self assembly of molecules for nanotechnology applications. Biomimetics, Biotemplating and *de novo* designed nanostructures and materials. DNA-Nanotechnology. DNA computers. Nanomanipulations, material design, synthesis and their applications.

**Biotech. 303 Molecular Marker Technology** **2+0 Sem. I**

Types of molecular markers - RFLP. PCR based markers - RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their variants. Uses of molecular markers - application as genetic tools for genotyping and gene mapping. Mapping populations - $F_2$, DH, RILs and NILs. Bulked segregant analysis. Linkage maps. Physical maps. Application of molecular markers - assessing genetic diversity, variety protection, Marker-assisted breeding for accelerated introgression of transgene, major genes and quantitative trait loci (QTLs). Human and animal health - association with genetic-based diseases. Paternity determination. Forensic studies.

**Biotech. 304 Genomics and Proteomics** **3+0 Sem. I**

Introduction to genomics, functional genomics and proteomics. Structural genomics. Classical ways of genome analysis, BAC and YAC libraries. Physical mapping of genomes. Next generation sequencing. Genome analysis and gene annotation. Genome projects - *E. coli*, Arabidopsis, Bovine, Human. Comparative genomics - orthologous and paralogous sequences, synteny, gene order, phylogenetic foot printing. Functional genomics. Differential gene expression techniques - ESTs, cDNA-AFLP, microarray, differential display, SAGE, RNAseq, Real time PCREDIT. Introduction to proteomics. Analysis of proteome - native poly acrylamide gel electrophoresis (PAGE), sodium dodecyl sulphate-poly acrylamide gel electrophoresis (SDS PAGE), 2D poly acrylamide gel electrophoresis (PAGE). Edmann degradation. Chromatographic techniques – high performance liquid chromatography (HPLC), gas chromatography (GC). Mass spectrometry – matrix associated laser desorption/ionization-time of flight (MALDI-TOF), liquid chromatography mass spectrometry (LC-MS). Post translational modifications.

**Biotech. 305 Biosafety, Bioethics and IPR** **2+0 Sem. I**

Biodiversity definition, importance and geographical causes for diversity. Species and population biodiversity, maintenance of ecological biodiversity hot spots in India. Convention on biological diversity. Cartagena protocol of bio-safety. Risk management for GMOs. Bio-safety guidelines, rulesand regulations and regulatory frame work for GMOs in India. Introduction to Intellectual Property, concepts and types. International treaties for protection of IPs. Indian legislations for the protectionof various types of Intellectual Property. Patent search, filing process. Material transfer agreements.

**Biotech. 306 Computational Biology** **2+1 Sem. II**

Introduction to computational biology. Web based servers and software for genome analysis: Ensembl, UCSC genome browser, MUMMER, BLASTZ. Sequence submission. Protein interaction databases: BIND, DIP, GRID, STRING, PRIDE. Principles of protein structure prediction. Fold recognition (threading). Homology modelling. SCOP, CATH, PDB, PROSITE, PFAM. Methods for comparison of 3D structures of proteins. Phylogenetic analysis: Evolutionary models, tree construction methods, statistical evaluation of tree methods. PHYLIP, dendroscope, MEGA. DNA barcoding database - BOLD.

**Practical:** Application of genome browsers in genomic research. Exploring protein-protein interaction databases. Working with protein structural classification databases. SCOP, CATH, PDB, PSD databases. SNP and SSR identification tools. PHYLIP. Genome browsers, microarray databases.

**Biotech. 307 Micropropagation Technologies** **1+2 Sem. II**

**[For students of B.Sc. (Hons.) Agriculture]**

Introduction to tissue culture and micropropgation techniques, their limitations and applications. Types of cultures - seed, embryo, organ, callus, cell. Stages of micropropagation. Axillary bud proliferation - shoot tip, meristem and bud cultures. Organogenesis - callus and direct organ formation. Somatic embryogenesis. Cell suspension cultures. Production of secondary metabolites. Somaclonal variation. Cryopreservation.

**Practical:** Nutrient media composition and preparation for specific cultures. Sterilization techniques for explants. Callus induction. Induction of somatic embryos. Regeneration of whole plants from different explants. Micropropagation of sugarcane, mentha, banana and citrus. Hardening procedures.

**Biotech. 308 Food Biotechnology** **2+1 Sem. II**

**[For students of B.Tech. Food Technology]**

Chemical nature, properties and functions of the genetic material. Organization of the genetic material in prokaryotes and eukaryotes. DNA replication. Transcription and translation - types of RNA and genetic code. Mutation and DNA repair. Genetic recombination in bacteria, transformation, transduction, conjugation. Regulation of gene expression in prokaryotes. Recombinant DNA technology - Restriction enzymes, cloning vectors, cloning procedures, Gene cloning. Biosensors classification, application in food industry. Application of biotechnology in food - immobilization of enzymes, arresting of cell in insoluble matrix, immobilized cell systems, cell attachment in a surface, aggregation, entrapment, containment, physical adsorption, covalent bonding, cross linking, entrapment into polymeric films, microencapsulation, large scale cell immobilization, uses and applications in industries. Ethical issues concerning GM foods. Testing for GMOs, bio-safety guidelines, risk assessment and risk management. Public perception of GM foods.

**Practical:** Study of auxotroph. Micro-propagation through tissue culture. Isolation and analysis of chromosomal/genomic DNA from *E. coli* and *Bacillus cereus*. Separation of protoplast using cellulytic enzymes. Production of biomass from fruit and vegetable waste. Introduction of ELISA, Southern blot. DNA finger printing. Agarose gel electrophoresis of plasmid DNA. Pesticide degradation by *Pseudomonas* spp.

**Biotech. 309 Nutrigenomics** **3+0 Sem. II**

**(For students of B. Sc. (Hons.) Nutrition and Dietetics)**

Genomics - Definition, scope and importance. Global impact of genomics. Genomics in health care, agriculture and environment. Processes and products of biotechnology. Application of genomics in development of nutritious foods. Genes - nature, concept and synthesis. Chemical nature of DNA, nucleotides and nucleosides. Structure of RNA and RNA splicing. Units of gene, gene expression, regulation and transcription. Epigenetic changes in relation to diet. Genetic engineering for humanhealth. Gene therapy and personalized medicine. Single cell protein. Role of genomics in enzymology and product development. Genetic improvement of food grade microorganisms. Nutritional significance of food products developed by biotechnological techniques. Scientific, technological and resource constraints on genomics. Factors affecting development in nutri genomics.

**Biotech. 310 Applications of Genomics and Proteomics** **2+1 Sem. II**

Structure of genomes - *Arabidopsis*, pigeonpea, rice, tomato, wheat. DNA chips and their use in transcriptome analysis. Mutants and RNA interference (RNAi) in functional genomics. Site directed mutagenesis. Transposon tagging. Transient gene expression – virus induced gene silencing (VIGS) and florescence activated cell sorting (FACS) based targeted genome editing technologies. Bio-informatics in proteomics - protein 3D structure modelling (Homology modelling and crystallography). Proteome analysis. Protein-protein interaction - FRET, yeast two hybrid and co-immunoprecipitation. Applications of genomics and proteomics in agriculture, human health and industry. Metabolomics and ionomics for elucidating metabolic pathways.

**Practical:** SDS-PAGE. 2D electrophoresis. Protein characterization through HPLC. Specialized crop based genomic resources - TAIR, Gramene, Graingenes, Maizedb, Phytozome, Cerealdb, Citrusdb. miRbase.

**Biotech. 311 Molecular Breeding** **2+1 Sem. II**

Principles of Plant Breeding. Breeding methods for self and cross-pollinated crops. Heterosis breeding. Limitations of conventional breeding. Methods of fruit crop improvement. Challengesin horticultural crop breeding, Pseudo test cross strategy for perennials with long juvenile period. Development of specific mapping populations.

QTL mapping using structured populations. Fine mapping of genes/QTL. Map based gene/QTL isolation and development of gene based markers. Marker assisted selection (MAS) - foreground and background

selection. MAS for major and minor genes. Marker assisted pyramiding. Marker assisted recurrent selection. Transgenic breeding. MAS for specific traits with examples. Commercial applications of MAS.

**Practical:** Working on some genotyping and phenotyping datasets for Linkage mapping using Mapmaker, MapDisto and QTL mapping softwares - WinQTL cartographer. Use of gene based and closely linked markers for foreground selection for target traits in target crops. Marker assisted detection of the transgene.

**Biotech. 312 Epigenetics and Gene Regulation 3+0 Sem. II**

DNA methylation and histone modifications. DNA methylases, methyl binding proteins and histone modifiers. Epigenetic changes in response to external stimuli leading to changes in gene regulation. Role of DNA methylation in plant development. Mutant case studies. Introduction to small RNAs. History, biogenesis. *In silico* predictions of miRNAs, target gene identification, methylation of heterochromatin by het associated siRNAs. Small RNAs electrophoresis using PAGE. Blotting of small RNAs on nylon membrane. Detection of small RNAs using fluorescent labelled probes. Gene regulation by small RNA. Other classes of siRNAs. Bisulphite sequencing for methylation detection. Role of small RNAs in epigenetics. Jacob Monod model of gene regulation. RNA editing, Genome imprinting.

**Biotech. 313 Programming for Bioinformatics 2+2 Sem. II**

Introduction – operating systems, programming concepts, algorithms, flow chart, programming languages, compiler and interpreter; Computer number format – Decimal, Binary, Octal and Hexadecimal. C-language: History, constant, variables and identifiers, character set, logical and relational operators, data input and output concepts; Decision making: if statement, if-else statement, for loop, while loop, do-while loop, arrays and functions, file handling. PERL-language

Introduction, variables, arrays, string, hash, sub-routines, file handling, conditional blocks, loops string operators and manipulators.

**Practical:** Constant, variables and identifiers, logical and relational operators, Programs related to arithmetic operations, arrays and file handling in C. Pattern matching and regular expressions in PERL, Sequence handling in PERL demonstrating string, array and hash. Shell programming - concepts and types of UNIX shell, Linux variables, if statements, control and iteration, arithmetic operations, concepts of awk, grep and sed. Sequence manipulations using shell scripting.

**Biotech. 314 Next Generation Sequencing and Data Analysis 2+1 Sem. II**

Introduction to first, second and third generation sequencing technologies; NGS Terminology; Applications of sequencing technologies. NGS Sequence file formats, data quality evaluation, pre-processing of data: quality control, adapter clipping, quality trimming; de-multiplexing. Bacterial genome assembly; Assessment of genome assembly, Tools for prokaryotic gene prediction (PROKKA); functional annotation (Blast, KEGG, BLAST2GO); domain and motif analysis (PFAM, interpro) Short read mapping tools (BWA, Bowtie); Visualization tools for genome assembly and mapped reads; data submission to SRA.

**Practical:** NGS sequence files format (FASTQ/BED/BAM/GFF), quality control (FastQC), adapter clipping (cutadapt), trimmomatic, Prokaryotic genome assembly (SPADES/soapdenovo), Gene prediction (PROKKA), Functional annotation (Blast/BLAST2GO/PFAM/interpro), Read mapping (BWA/Bowtie), Visualization of mapped reads (IGV/Tablet). Mediated genetic transformation. Particle gun mediated genetic transformation. Histochemical GUS assays. PCR screening of putative transgenic plants. Raising transgenic plants under contained conditions.

**Biotech. 491 In-house Skill Development in Plant Biotechnology 0+20**

**Biotech. 492 In-house Skill Development in Bioinformatics 0+20 Sem. I**

B. Tech (Biotech.) students will register for either Biotech. 491 or Biotech. 492 in 7$^{th}$ semester. They will be demonstrated and imparted hands on training on different tissue culture, molecular biology and bioinformatics techniques at School of Agricultural Biotechnology.

**Biotech. 493 Project Formulation, Execution and Presentation** **0+10** **Sem. II**

The students (2 or 3) will be allotted to each faculty member of School of Agricultural Biotechnology and associated faculty member for Project Formulation, Execution and Presentation.

**Biotech. 494 Entrepreneurial Development in Biotechnology** **0+10** **Sem. II**

Modules: Micropropagation, DNA fingerprinting, Genetic purity for maintenance breeding, Markerassisted selection, Database Management skills

## Post Graduate Courses

**MBB-501 Principles of Biotechnology** **3+0** **Sem. I**

**Unit I** History, scope and importance of Biotechnology; Specializations in Agricultural Biotechnology: Genomics, Genetic engineering, Tissue Culture, Bio-fuel, Microbial Biotechnology, Food Biotechnology etc. Basics of Biotechnology.

**Unit II** Structure of DNA, RNA and protein, their physical and chemical properties. DNA function: Expression, exchange of genetic material, mutation. DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; DNA/RNA libraries; recombinant DNA technology; Nucleic acid hybridization; DNA/ RNA libraries; Applications of gene cloning in basic and applied research, Plant transformation: Gene transfer methods and applications of GM crops.

**Unit III** Molecular analysis of nucleic acids -PCR and its application in agriculture and industry, Introduction to Molecular markers: RFLP, RAPD, SSR, SNP etc., and their applications; DNA sequencing, different methods; Plant cell and tissue culture techniques and their applications. Introduction to genomics, transcriptomics, ionomics, metabolomics and proteomics. Plant cell and tissue culture techniques and their applications.

**Unit IV** Introduction to Emerging topics: Genome editing, gene silencing, Plant microbialinteractions, Success stories in Biotechnology, Careers and employment in biotechnology. Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

**MBB-502 Fundamentals of Molecular Biology** **3+0** **Sem. I**

**Unit I** Historical developments of molecular biology, Nucleic acids as genetic material, Chemistry and Nomenclature of nucleic acids; Structure of DNA: primary structure; secondary structure, Forms of DNA: A, B, Z and their function; Structure and Types of RNA Genome organization in prokaryotes and eukaryotes; DNA Topology; DNA re-association kinetics, Types of repeat sequences.

**Unit II** Central dogma of Molecular Biology; DNA replication- Classical experiments, Models of DNA replication; DNA replication, Origin and Steps in DNA replication - initiation, elongation and termination; Enzymes and accessory proteins and its mechanisms; Eukaryotic DNA replication in brief. Types of DNA damages and mutations; DNA repair mechanisms, Recombination: Homologous and non-homologous, Genetic consequences.

**Unit III** Prokaryotic transcription, initiation, elongation and termination, promoters, Structure and function of eukaryotic RNAs and ribosomal proteins. Eukaryotic transcription – RNA polymerase I, II and III, Elongation and Termination, Eukaryotic promoters and enhancers, Transcription factors, Post transcriptional processing, Splicing: Catalytic RNAs, RNA stability and transport, RNA editing.

**Unit IV** Genetic code and its characteristics, Universal and modified genetic code and its characteristics, Wobble hypothesis; Translational machinery; Ribosomes in prokaryotes and Eukaryotes. Initiation complex formation, Cap dependent and Cap independent initiation in eukaryotes, Elongation: translocation, transpeptidation and termination of translation; Co- and Post-translational modifications of proteins; Translational control; Protein stability -Protein turnover and degradation.

**Unit V** Gene regulation in prokaryotes, Constitutive and Inducible expression, small molecule regulators; Operon concept: *lac* and *trp* operons, attenuation, anti- termination, stringent control. Gene regulation in eukaryotes– regulatory RNA and RNA interference mechanisms, Silencers, insulators, enhancers, mechanism of silencing and activation; Families of DNA binding transcription factors: Helix-turn- helix, helix-loop-helix etc. Epigenetic regulations.

**MBB-503 Molecular Cell Biology 3+0 Sem. I**

**Unit I** Origin of life, History of cell biology, Evolution of the cell: endo-symbiotic **Theory**, tree of life, General structure and differences between prokaryotic and eukaryotic cell; Similarities and distinction between plant and animal cells; different kinds of cells in plant and animal tissues.

**Unit II** Cell wall, cell membrane, structure and composition of bio-membranes, Structure and function of major organelles: Endoplasmic reticulum, Ribosomes, Golgi apparatus, Mitochondria, Chloroplasts, Lysosomes, Peroxisomes, Micro-bodies, Vacuoles, Nucleus, Cyto-skeletal elements.

**Unit III** Membrane transport; Diffusion, osmosis, ion channels, active transport, mechanism of protein sorting and regulation of intracellular transport, transmembrane and vesicular transport - endocytosis and exocytosis; General principles of cell communication: hormones and their receptors, signaling through G-protein coupled receptors, enzyme linked receptors; signal transduction mechanisms and regulation, Cell junctions, Cell adhesion, Cell movement; Extracellular matrix.

**Unit IV** Chromatin structure, Cell division and regulation of cell cycle; Mechanisms of cell division, Molecular events at M phase, mitosis and cytokinesis, Ribosomes in relation to cell growth and division, Extracellular and intracellular Control of Cell Division; abnormal cell division: cancer- hall marks of cancer and role of oncogenes and tumor suppressor genes in cancer development - Programmed cell death (Apoptosis).

**Unit V** Morphogenetic movements and the shaping of the body plan, Cell diversification, cell memory, cell determination, and the concept of positional values; Differentiated cells and the maintenance of tissues and organ development; Stem cells: types and applications; Basics of Animal development in model organisms (C. elegans; Drosophila); Plant development.

**MBB-504 Techniques in Molecular Biology I 0+3 Sem. I**

**Practical** Good lab practices, preparation of buffers and reagents. Principle of centrifugation and spectrophotometry. Growth of bacterial culture and preparation of growth curve, Isolation of Genomic DNA from bacteria. Isolation of plasmid DNA from bacteria. Growth of lambda phage and isolation of phage DNA. Isolation and restriction of plant DNA (e.g., Rice / Moong / Mango / Marigold). Quantification of DNA by (a) Agarose Gel electrophoresis and (b) Spectrophotometry PCR using isolated DNA. PAGE Gel electrophoresis. Restriction digestion of plasmid and phage DNA, ligation, Recombinant DNA construction. Transformation of E. coli and selection of transformants. Chromatographic techniques (a) TLC (b) Gel Filtration Chromatography, (c) Ion exchange Chromatography, (d) Affinity Chromatography. Dot blot analysis, Southern hybridization, Northern hybridization. Western blotting and ELISA. Radiation safety and non-radio isotopic procedure.

**MBB-505 Omics and Systems Biology 2+1 Sem. II**

**Unit I** Different methods of genome sequencing, principles of various sequencing chemistries, physical and genetic maps, Comparative and evolutionary genomics, Organelle genomics, applications in phylogenetics, case studies of completed genomes, preliminary genome data analysis, basics of ionomics analysis, different methods.

**Unit II** Protein-basics: primary-, secondary- and tertiary structure, Basics of X-ray crystallography and NMR, Principal and Applications of mass spectrometry, Proteomics: Gel based and gel free, Basics of software used in proteomics, MASCOT, PD-Quest etc., Study of protein interactions, Prokaryotic and yeast-based expression system and purification.

**Unit III** Metabolomics and its applications, Use of 1D/2D NMR and MS in metabolome analysis, Multivariate analysis and identification of metabolite as biomarkers, Study of ionome using inductively coupled plasma – mass spectroscopy (ICP-MS), X-Ray Fluorescence (XRF), Neutron activation analysis (NAA), Data integration usinggenome, transcriptome, proteome, metabolome and ionome with phenome.

**Unit IV** Introductory systems Biology - The biochemical models, genetic models and systems model, Molecules to Pathway, Equilibrium binding and cooperatively – Michaelis- Menten Kinetics, Biological oscillators, Genetic oscillators, Quorum Sensing, Cell-cell communication, Drosophila Development, Pathways to Network ,Gene regulation at a single cell level, transcription network, REGULATORY

CIRCUITS, Negative and positive auto-regulation, Alternative Stable States, Bimodal Switches, Network building and analysis.

**Practical** Isolation of HMW DNA and brief overview of sequencing, Primary information on genome data analysis. BSA Standard curve preparation, Extraction of protein and estimation methods. Quantification of proteins from different plant tissues using spectrophotometry. 2-D Gel Electrophoresis, 2-D Image analysis. Experiments on protein-protein interaction (Yeast 2-hybrid, Split Ubiquitin system). Demonstration on MALDI-TOF. Demonstration on ICP-MS, AAS, Nitrogen estimation using various methods.

**MBB-506 Plant Genetic Engineering** **3+0** **Sem. I**

**Unit I** Historical background, Restriction Enzymes; DNA Modifying enzymes, ligase, T4 DNA polymerase, Polynucleotide kinase etc., Cohesive and blunt end ligation; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes,Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions: Electromobility shift assay.

**Unit II** Plasmids; Bacteriophages; M13, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors, (YACs; BACs); Animal Virus derived vectors-SV-40; Expression vectors; pMal, pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Baculovirus vectors system, Plant based vectors, Ti and Ri plasmids as vectors, Yeast vectors, Shuttle vectors. Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning, Jumping and hopping libraries, Protein- protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression; Codon optimization for heterologous expression. Introduction of DNA into mammalian cells; Transfection techniques.

**Unit III** Principles of PCR, Primer design, DNA polymerases, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Applications of PCR in gene recombination,Site specific mutagenesis, in molecular diagnostics; Viral and bacterial detection; Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay.

**Unit IV** Genetic transformation of plants: DNA delivery – Agrobacterium mediated method. Direct DNA delivery – chemical mediated electroporation and particle bombardment. Vectors and transgene design - Promoters and Marker genes. Chloroplast transformation. Development of marker-free plants. Analysis of transgenic plants – molecular and Biochemical assays, genetic analysis - Identification of gene integration site - Advance methods – cis genesis, intragenesis and targeted genome modification – ZFN, TALENS and CRISPR. Application of transgenic technology.

**MBB-507 Techniques in Molecular Biology II** **0+3** **Sem. II**

**Practical** Construction of gene libraries (cDNA and Genomics). Synthesis and cloning of cDNA. Real time PCR and interpretation of data. Molecular markers (i) RAPD. (ii) SSR. (iii) AFLP / ISSR and their analysis. Case study of SSR markers - construction of linkage map. QTL analysis using genotypic data based on SSR. SNP identification and analysis. Proteomics (i) 2D gels, (ii) Mass spectrometry. RNAi - designing of construct, phenotyping of the plant. Yeast 1 and 2-hybrid interaction. Generation and screening of mutants. Transposon mediated mutagenesis. Immunology and molecular diagnostics: Ouchterlony double diffusion, Immunoprecipitation, Radiation Immunodiffusion, Immunoelectrophoretic, Rocket Immunoelectrophoretic, Counter Current Immunoelectrophoretic, ELISA, Latex Agglutination, Immunohistochemistry.

**MBB-508 Introduction to Bioinformatics** **2+1** **Sem. I**

**Unit I** Bioinformatics basics, scope and importance of bioinformatics; Biological databases for DNA and Protein sequences -PIR, SWISSPROT, GenBank, DDBJ, secondary database: PFAM, PROSITE, structural databases –PDB, SCOP and CATH, Specialized genomic resources, SRA database.

**Unit II** Bioinformatics Tools Facilitate the Genome-Wide Identification of Protein-Coding Genes, Sequence analysis, Sequence submission and retrieval system-SEQUIN, BANKit, Webin, Sequence alignment, pair wise alignment techniques, multiple sequence alignment; Tools for Sequence alignment-BLAST and its variants; Phylogenetic analysis- CLUSTAL X, CLUSTAL W, Phylip, Tcoffee.

**Unit III** Sequencing of protein; Protein secondary structure prediction- Chousfasman, GOR Method, Protein 3DStructure Prediction: Homology Modeling and Ab-inito method; Evaluation of models- Structure validation and refinement - Ramachandran plot, SAVES. Protein function prediction- sequence and domain based, SSR marker identification and Primer designing- principles and methods. Drug discovery, Structure Based Drug Design- Rationale for computer aided drug designing, basic principles, docking, Structure visualization tools: rasmol, chimera.

**Practical :** Usage of NCBI resources Retrieval of sequence/structure from databases and submission. Different Databases, BLAST exercises. Gene/ORF prediction software; Assembly of DNA and RNA Seq data. Annotation of assembled sequences, Phylogenetics and alignment. Visualization of structures, Docking of ligand receptors. Protein structure analysis and modeling.

**MBB-509 Plant Tissue Culture** **2+1** **Sem. I**

**Unit I** History of plant tissue culture, principle of Totipotency; Tissue culture media; Plant hormones and morphogenesis; Direct and indirect organogenesis; Direct and indirect somatic embryogenesis; Applications of plant tissue culture; National certification and Quality management of TC plants; Genetic Fidelity testing and Virus indexing methods – PCR, ELISA.

**Unit II** Micropropagation of field and ornamental crops; Virus elimination by meristem culture, meristem tip culture and micrografting; Virus indexing in tissue culture plants (Using PCR and ELISA); Androgenesis and gynogenesis - production of androgenic and gynogenic haploids - diploidization; Protoplast culture - isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybridization - Production of Somatic hybrids and Cybrids; Wide hybridization - embryo culture and embryo rescue techniques; Ovule, ovary culture and endosperm culture.

**Unit III** Large-scale cell suspension culture - Production of alkaloids and other secondarymetabolites-techniques to enhance secondary metabolite production, Somaclonal and gametoclonal variations – causes and applications; Callus culture and in vitro screening for stress tolerance; Artificial seeds, In vitro germplasm storage andcryo- preservation. Commercial Tissue Culture: Case studies and success stories, Market assessment; project planning and preparation, economics, government policies.

**Practical :** Preparation of stocks- macronutrients, micronutrients, vitamins and hormones, filter sterilization of hormones and antibiotics. Preparation of Murashige and Skoogmedium. Micro-propagation of plants by nodal and shoot tip culture. Embryo culture to overcome incompatibility, Anther culture for haploid production. Callus induction in rice, regeneration of shoots, root induction, role of hormones in morphogenesis. Acclimatization of tissue culture plants and establishment in greenhouse. Plan of a commercial tissue culture unit.

**MBB-510 Microbial/ Industrial Biotechnology** **2+1** **Sem. II**

**Unit I** Introduction, scope and historical developments; Isolation, screening and geneticimprovement (involving classical approaches) of industrially important organisms.

**Unit II** Primary metabolites, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics as case study; Recombinant DNA technologiesfor microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes forproduction of novel product for industry.

**Unit III** Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries; Bio-transformations, Bioreactors, their design and types; Immobilized enzymes-based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes.

**Unit IV** Environmental Biotechnology, biotreatment for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bio- remediation of soil; Production of eco-friendly agricultural chemicals, bio- pesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

**Practical :** Isolation of industrially important microorganisms, their maintenance and improvement. Lab scale production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery. Study of bio-reactors and their operations. Production of bio-fertilizers. Experiments on microbial fermentation process ofantibiotics, bio-pigments, dairy products, harvesting purification and recovery of

end products. Immobilization of cells and enzymes, studies on its kinetic behaviour, growth analysis and biomass estimation. Determination of mass transfer coefficient.

**MBB-511 Molecular Plant Breeding** **2+1** **Sem. II**

**Unit I** Inheritance of qualitative and quantitative traits. Heritability – its estimation, Population structure of self- and cross-pollinated species, Factors affecting selection

efficiency. Development of different kinds of segregating populations – $F_2$, $F_3$, $BC_1F_1$, $BC_1F_2$, $BC_4F_2$, RIL (Recombinant Inbred Lines), AIL (Advanced Intercrossed Lines), DH (Di-haploid population), NIL (Near Isogenic lines), NAM (Nested Association Mapping), MAGIC (Multi-parent Advanced Generation Intercross population).

**Unit II** Causes of sequence variation and its types, Types of molecular markers and development of sequence based molecular markers – RFLP, AFLP, SCARs, CAPS, SSRs, STMS, SNPsInDel and DARTseq; Inheritance of markers, Linkage analysis using test cross, F2, F3, BC1F1, RIL. Construction of genetic map, Mapping genes for qualitative traits; Genotyping by sequencing and high-density chip arrays.

**Unit III** QTL mapping using structured populations; Association mapping using unstructured populations; Genome Wide Association Studies (GWAS), Principle of Association mapping– GWAS-SNP genotyping methods, DART array sequencing, Illumina's Golden Gate Technology, Genotyping by sequencing methods- Fluidigm; GBS, Illumina Hi seq- Nano pore sequencing, Principles and methods of Genomic Selection, Fine mapping of genes/QTL; Development of gene-based markers; Allele mining by TILLING and Eco-TILLING.

**Unit IV** Tagging and mapping of genes. Bulk segregant and co-segregation analysis, Marker assisted selection (MAS); Linked, unlinked, recombinant, flanking, peak markers. Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples. Haplotype concept and Haplotype-based breeding; Genetic variability and DNA fingerprinting. Molecular markers in Plant variety protection, IPR issues, hybrid purity testing, clonal fidelity testing and transgenic testing.

**Practical** Construction of linkage map. QTL analysis using the QTL cartographer and other software. SNP data analysis using TASEEL. Detection of haplotype block using SNP data – pLinksoftware. Genotyping by sequencing methods–Illumina genotyping platform. Marker assisted breeding – MABB case studies quality traits in rice/maize. Genome Assisted Breeding in model crops, Genomic Selection models using the morphological and SNP data.

**MBB-512 IPR, Bio-safety & Bioethics** **2+0** **Sem. II**

**Unit I** IPR: historical background in India; trade secret; patent, trademark, design & licensing; procedure for patent application in India; Patent Cooperation Treaty (PCT); Examples of patents in biotechnology- Case studies in India and abroad; copyright and PVP; Implications of IPR on the commercialization of biotechnology products, ecological implications; Trade agreements- The WTO and other international agreements, and Cross border movement of germplasms.

**Unit II** Biosafety and bio-hazards; General principles for the laboratory and environmental bio-safety; Biosafety and risk assessment issues; handling and disposal of bio- hazards; Approved regulatory laboratory practice and principles, The Cartagena Protocol on biosafety; Biosafety regulations in India; national Biosafety Policy and Law; Regulations and Guidelines related to Biosafety in other countries.

**Unit III** Potential concerns of transgenic plants – Environmental safety and food and feed safety. Principles of safety assessment of Transgenic plants – sequential steps in risk assessment. Concepts of familiarity and substantial equivalence. Risk - Environmental risk assessment – invasiveness, weediness, gene flow, horizontal gene transfer, impact on non-target organisms; food and feed safety assessment – toxicity and allergenicity. Monitoring strategies and methods for detecting transgenics.

**Unit IV** Field trails – Biosafety research trials – standard operating procedures, labeling of GM food and crop, Bio-ethics-Mankind and religion, social, spiritual & environmental ethics; Ethics in Biotechnology, labeling of GM food and crop; Biopiracy.

**MBB-513 Immunology and Molecular Diagnostics** **3+0 Sem. II**

**Unit I** Immunity and its classification; Components of innate and acquired immunity; Lymphatic system; Hematopoiesis; Organs and cells of the immune system- primary,secondary and tertiary lymphoid organs Descriptions of Antigens - immunogens, hapten and adjuvants.

**Unit II** Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Basis of self and non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cluster of Differentiations (CDs), Cytokines-properties, receptors and therapeutic uses.

**Unit III** Phagocytosis; Complement and Inflammatory responses; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility,HLA typing; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system.

**Unit IV** Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques MBB 513 Immunology and Molecular Diagnostics 3+0 - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Transgenic mice, Gene knock outs.

**Unit V** Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccinetechnology-Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies, Immunity to Infection, Bacteria, viral, fungal and parasitic infections , Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases, MHC and TCR in autoimmunity; Transplantation, Immunological basis of graft rejection, immunosuppressive therapy; Tumor immunology – Tumor antigens.

**MBB-514 Nano Biotechnology** **2+1 Sem. II**

**Unit I** Introduction to Nanotechnology - Nanomaterials - Self-assembly to artificial assembly for creation of useful nanostructures – Bottoms up and Top-down approach (Nano rods, nano cages, nanotubes, quantum dots, nanowires, metal/polymer-based nanostructures)- Preparation and Characterization of nanoparticles (particle size analyzer, microscopy viz., electron microscopy, atomic force microscopy etc.,).

**Unit II** Cell structure – Bio macromolecules: Types, Structure, Dynamics- Cellular nanomachines – cellular transducers, membrane channels, membrane transporters, Membrane motors – Creation of bio-nanostructures.

**Unit III** Chemical, physical and biological properties of biomaterials and bio response:biomineralization, structure-property relationships in polymeric materials*;* Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems.

**Unit IV** Nanoparticular carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano- imaging, Metabolic engineering and Gene therapy.

**Practical** Physical or chemical techniques for the synthesis of metal or metal oxide nanoparticles

(a) Synthesis of Zinc Oxide nanoparticle, (b) Synthesis of Nickel metal nanoparticle,

(c) Synthesis of Iron Oxide Nanoparticle, (d) Quantum dot preparation. Synthesis and characterization of Carbon Nano-materials (a) Sputtering technique, (b) Purification and characterization of carbon nano materials by microscopy techniques. Biogenic synthesis of Gold/silver nanoparticles. Preparation of thin films of nanomaterials.

**MBB-515 Environmental Biotechnology** **3+0 Sem. I**

**Unit I** Basic concepts and environmental issues; types of environmental pollution; problems arising from high-input agriculture; methodology of environmental management; air and water pollution and its control; waste water treatment - physical, chemical and biological processes; need for water and natural resource management.

**Unit II** Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals, detergents etc., aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc.,); anaerobic processes: digestion, filtration, etc.

**Unit III** Renewable and non-Renewable resources of energy; energy from solid waste; conventional fuels and their environmental impact; biogas; microbial hydrogen production; conversion of sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture etc.

**Unit IV** Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by microorganisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management environmental problems.

**MBB-516 Bio-entrepreneurship** **1+0 Sem. II**

**Unit I** Scope in biotechnology; types of bio-industries – bio-pharma, bio-agri, bio-services and bio-industrial; Importance of entrepreneurship; introduction to bio entrepreneurship

biotechnology in a global scale; – skills for successful entrepreneur–creativity, leadership, managerial, team building, decision making; opportunities for bio- entrepreneurship- entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India).

**Unit II** Business plan preparation; business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/support from various agencies; statutory and legal requirements for starting a company/venture.

**Unit III** Entry and exit strategy; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for 'virtual startup company'. Pricing strategy.

**Unit IV** Knowledge centers e.g., in universities, innovation centres, research institutions (public & private) and business incubators; R&D for technology development and upgradation; assessment of technology development; managing technology transfer.

**MBB-517 Stress Biology and Genomics** **2+0 Sem. I**

**Unit I** Different kinds of stresses (biotic and abiotic) and adaptation strategies: Plant cells as a sensor of environmental changes; role of cell membranes in signal perception; Ways of signal transduction in cells and whole plants as a response to external factors. Abiotic stresses affecting plant productivity – Drought, salinity, water logging, temperature stresses, light stress and nutrient stress; Drought stress – Effects on plant growth and development; Components of drought resistance; Physiological, biochemical and molecular basis of tolerance mechanisms.

**Unit II** Strategies to manipulate drought tolerance – Osmotic adjustment and Osmoprotectants - synthesis of proline, glycine betaine, poly amines and sugars; ROS and antioxidants; hormonal metabolism - ABA signaling; signaling components – transcription factors. Water logging stress – effects on plant growth and metabolism; adaptation to water logging, tolerance mechanisms -hormones and flooding tolerance. Strategies for improving submergence tolerance. Salinity stress – effects on physiology and metabolism of plants, SOS pathways and ion homeostasis, Strategies to improve salinity tolerance in plants. Physiological and biochemical changes – High & Low temperature tolerance mechanisms - molecular basis of thermo tolerance. Morphological and physiological changes in plants due to high and low light stresses - photo oxidation -plastid development. Characters of heliophytes and sciophytes solar tracking – sieve effect and light channeling. Heavy metal stress – Al and Cd stress - effects on plant

growth and development, biotech Strategies to overcome heavy metal stress Nutrient stress- effects on plant growth and development. Genetic manipulation strategies to overcome the stress effects.

**Unit III** Biotic stresses (insects and pathogens): Mode of infection/infestation, physiological effects. Details of host-pathogen interaction and regulatory networks to understand resistance mechanism. Molecular approaches to counteract biotic stresses. Genomics; transcriptomes, small RNAs and epigenomes; functional genomics; transfer of tolerance/resistant genes to model plants and validation of gene function. Different techniques for the functional validation of genes. Signaling pathway related to defense gene expression, R proteins, RNAi approach and genes from pathogens and other sources, coat protein genes, detoxification genes, transgenic and disease management. Bt proteins, resistance management strategies in transgenic crops, ecological impact of field release of transgenic crops. Bioinformatics approaches to determine gene function and network in model plants under stress.

**MBB-518 Gene Regulation** **2+0** **Sem. I**

**Unit I** Transcriptional regulation – Regulatory proteins, Activators and Repressors, Binding of RNA polymerase, Allosteric regulation, DNA looping, Cooperative binding, Anti- termination, Combinatorial control – Regulation of lac, trpandara Operons. Gene regulation in Lambda phage – lytic or lysogenic establishment.

**Unit II** Regulatory sequences – Promoters, Enhancers, Silencers, Insulators, Locus Control Region. Activator proteins and their binding sites, DNA binding domain – Homeodomain, Zinc containing proteins, Leucine Zipper Motif, Helix-Loop-Helix, HMG proteins. Recruitment of RNA polymerase to promoter region and transcription mechanism. Nucleosome and chromatin assembly. Nucleosomes and their modifiers. Signal integration. Signal transduction and transcriptional regulation. Post-transcriptional gene regulation: Gene Silencing. Epigenetic gene regulation.

**Unit III** Regulation by RNA in prokaryotes and eukaryotes, RNA as defense agents. Ribo-switches. Gene Silencing by RNA - siRNA & miRNA – synthesis and function. Non- coding RNAs their impact, categories and role in gene regulation, chromatin assembly etc.

**Unit IV** Negative auto-regulation, Positive auto-regulation.

**MBB-591 Seminar** **1+0**

**MBB-599 Master's Research** **0+30**

## Ph.D. courses

**MBB-601 Plant Molecular Biology** **3+0** **Sem. I**

**Unit I** Model Systems in Plant Biology (Arabidopsis, Rice etc.) Forward and Reverse Genetic Approaches. Organization expression and interaction of nuclear, mitochondrial and chloroplast genomes. Cytoplasmic male sterility.

**Unit II** Transcriptional and Post-transcriptional Regulation of Gene Expression, Isolation of promoters and other regulatory elements, RNA interference, Transcriptional Gene Silencing, Transcript and Protein Analysis.

**Unit III** Plant Developmental Processes, ABC Model of Floral Development, Role of hormones (Ethylene, Cytokinin, Auxin and ABA, SA and JA) in plant development. Regulation of Flowering, Plant photoreceptors and light signal transduction, vernalization, Circadian Rhythms.

**Unit IV** Abiotic Stress Responses: Salt, Cold, Heat and Drought. Biotic Stress Responses. Molecular Biology of Plant pathogen Interactions, Molecular Biology of Rhizobium and Agrobacterium-Plant interaction. Role of programmed Cell Death in Development and Defense.

**MBB-602 Plant Genome Engineering** **3+0** **Sem. II**

**Unit I** Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular marker, transformation and genomic tools for crop improvement. Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc.,) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc.,) stresses; Genetic Engineering for

increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients etc.); edible vaccines, etc.

**Unit II** Recent developments in plant transformation strategies; Role of antisense and RNAi- based gene silencing in crop improvement; Regulated and tissue-specific expression of transgenes for crop improvement.

**Unit III** Gene stacking; Pathway engineering; Marker-free transgenic development strategies; Genome editing: principles and methods, Development of genome edited plants; High throughput phenotyping of transgenic plants.

**Unit IV** Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

**MBB-603 Plant Omics and Molecular Breeding** **3+0** **Sem. I**

**Unit I** Genetic and physical mapping of genomes, Concepts and methods of next generation sequencing (NGS), assembly and annotation of NGS data, genome resequencing, DNA sequence comparison, annotation and gene prediction. Genome-wide insertion mutagenesis and its use in functional genomics, transcriptome profiling using microarrays and deep sequencing, study of methylome and its significance. Complex traits and genetic architecture, Mapping genes and QTLs, statistical concepts in QTL mapping, high-throughput genotyping using automated platforms.

**Unit II** Marker assisted breeding (MAB): Principles and methods, marker assisted foreground and background selection, marker assisted recurrent selection, whole genome selection, case studies in MAS, requirement for successful marker assisted breeding, cost of MAB.

**Unit III** Study of population structure and kinship, association genetic analysis of QTL, case studies on QTL mapping using different approaches, map-based of cloning genes and QTLs – case studies. Proteome analysis using mass spectrometry, crystallography and NMR, analysis of proteome data, study of protein-protein interactions.

**Unit IV** Study of the metabolome, use of 1D/2D NMR and MS in metabolome analysis, multivariate analysis and identification of metabolite as biomarkers, study of ionome using inductively coupled plasma – mass spectroscopy (ICP-MS), correlating the data from genome, transcriptome, proteome, metabolome and ionome with phenome.

**MBB-604 Commercial Plant Tissue culture** **2+0** **Sem. I**

**Unit I** Micro-propagation of commercially important plant species; plant multiplication, hardening, and transplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

**Unit II** Production of useful compounds via biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

**Unit III** Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethical issues; management and commercialization.

**Unit IV** Project planning and preparation, economics (entrepreneurship, cost profit ratio), government policies (incubators, different facilitation projects, loan opportunities). Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

**MBB-605 Plant Microbe Interaction** **2+0** **Sem. II**

**Unit I** Microbial communities in the soil and atmosphere, Community dynamics and population interactions with particular reference to plant–microbe and microbe- microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions, effects of microorganisms on plants, effects of plants on microorganisms. Recognition processes and signal exchange, Molecular aspects of Plant Growth Promoting Rhizobacteria (PGPR), Symbiotic diazotrophs: Rhizobia and association with

legumes. Mycorrhizal associations: Ectomycorrhizae, Endomycorrhizae with particular emphasis to AM fungi, Ectendomycorrhizae. Biocontrol agents and their action, endophytes associations.

**Unit II** Enzymes, toxins, pili, siderophores, secretion systems of microbes and plants determining soil health, nutrient availability and uptake defense responses in plants: pamp-triggered immunity, effector-triggered susceptibility, qualitative resistance, r genes, structure and function, effector-triggered immunity, regulation of plant cell death, plant hormones in immunity, Plant parasite interactions and its molecular basis and impact on plant functions including photosynthesis, respiration, nitrogen metabolism and translocation.

**Unit III** Quorum sensing in bacteria, understanding microbiome, phytobiomes, dynamics, Applied and ecological aspects of symbioses and pathogen defense, techniques to study plant microbe interaction including microbe tagging, metagenomics and use of organismal databases to identify genes involved in interactions. Industrial application of agriculturally important microbes.

**Unit IV** Resistance mechanisms against attack by plant pathogens, gene-for-gene interactions; induced resistance; non-host resistance. Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Plant and microbial gene expression and signal exchange, specific regulators for different interactions including transgenic plants. Recognition mechanism and signal transduction during plant - pathogen interaction.

**MBB-606 RNA Biology** **1+0** **Sem. II**

**Unit I** RNA structure, functional evolution: RNA structure, types of RNA and function; Genome evolution- RNA as genetic material to regulatory molecule, Non-Coding RNAs, structure, function and regulation.

**Unit II** RNA synthesis, processing and regulation: transcription and its regulation in prokaryotes and eukaryotes; RNA splicing, alternate splicing and RNA editing; Translation and its regulation in prokaryotes and eukaryotes.

**Unit III** Genome regulation: Prokaryotic- attenuation, ribozymes, aptamers, riboswitches, CRISPER-Cas; eukaryotic-Exon skipping, nonsense-mediated decay, RNAi, Long non-coding RNA.

**Unit IV** Epigenetic regulation. RNA-based gene silencing technologies and their applications for crop improvement.

**MBB-607 Plant Hormones and Signaling** **2+0** **Sem. I**

**Unit I** Hormone Biosynthesis, Metabolism and its Regulation: Auxin biosynthesis and metabolism, Gibberellin biosynthesis and Inactivation, Cytokinin biosynthesis and metabolism, Ethylene biosynthesis, Abscisic acid biosynthesis and metabolism, Brassinosteroid biosynthesis and metabolism. Salicylic acid and jasmonate biosynthesis and metabolism.

**Unit II** Functioning of hormones in plant growth and development: Transport of Auxins, Induction of vascular tissues by Auxin, Hormones and the regulation of water balance, seed development and germination, Hormonal control of daylength and senescence.

**Unit III** Action of Hormones: Hormones in defense against insects and disease; Role of jasmonates, salicylic acids and peptide hormones for defense, growth, development and reproduction; Methods of plant hormone analysis. NPR 1 dependent Salicylic acid signaling, PAMP and effector triggered immunity, systemic acquired resistance and SA signaling.

**Unit IV** Hormone Signal Transduction: Auxin metabolism, transport and signal transduction, Cytokinin types, synthesis, metabolism, transport and signal transduction, Gibberellin biosynthesis, transport, signal transduction in stem elongation & Leaf Growth, Ethylene metabolism, perception and signaling in seedling growth and development, Ethylene signal transduction in fruits and flowers, Abscisic acid metabolism, transport and signal transduction in nuclear gene expression and stomatal responses. Brassinosteroid biosynthesis, catabolism and signal transduction. Strigalactone biosynthesis, transport and signaling in plant parasitism and symbiosis. Methods of Plant Hormone Analysis: Quantitative analysis of plant hormones based on LC/MS.

**MBB-608 Computational and Statistical Tools in Biotechnology 2+1 Sem.II**

**Unit I** Basic molecular biology; introduction to the basic principles of structure/function analysis of biological molecules; genome analysis; different types and classification of genome databases (e.g. HTGS, DNA, Protein, EST, STS, SNPs, Unigenes, Ensembl etc.)

**Unit II** Statistical Techniques: MANOVA, Cluster analysis, Discriminant analysis, Principalcomponent analysis, Principal coordinate analysis, Multidimensional scaling; Multiple regression analysis; Likelihood approach in estimation and testing; Resampling techniques – Bootstrapping and Jack- knifing; Markov Models. Hidden Markov Models, Bayesian estimation and Gibbs sampling.

**Unit III** DNA sequence retrieval system, various DNA and protein sequence file formats, DNAsequence analysis, different gene prediction models and gene annotation tools.

**Unit IV** Protein sequence analysis and structure prediction, comparative genome analysis,phylogenetic analysis, gene expression analysis tools,programming languages and their applications in bioinformatics.

**Practical :** Different types of databases and database search and retrieval, DNA and protein sequence analysis, Similarity searching and multiple alignments, Gene annotation, Phylogenetic analysis, Sequence analysis, Protein structure prediction, Analysis of microarray data, Programming languages in bioinformatics.

**MBB -610/GPB-610 Genome editing in plants 2+0 Sem. II**

**Unit I** Changing phase of plant breeding: from classical to targeted breeding. Molecular basis of recombination and DNA repair. Restriction enzymes: types and its importance.

**Unit II** Early history of specific gene modifications. Origin of targeted breeding: Zinc fingerand ZFN, TALEs and TALENs, use in targeted modifications. Discovery of CRISPR/Cas as a defense tool in bacteria. Types of CRISPR/Cas system in bacteria.

**Unit III** Designing CRISPR/Cas9 system for targeted breeding. Advances in CRISPR/Cas system for targeted genetic changes: nickases, Cas12a, Cas12b, Base editors, prime editors.Practical considerations in genome editing: target identification, designing gRNA, construct design, stage selection, construct delivery methods, mutant identification strategies. Multiplex genome editing. Transgene free methods in genome editing. CRISPR-ACT: CRISPR mediated gene activation and deactivation. Epigenome editing and its potentials.

**Unit IV** Recent advances in genome editing. Applications of genome editing. Biosafety andregulatory considerations. Important case studies. Potential of gene editing for nutritional security, natural resource conservation and climate resilience.

**MBB-691 Seminar I 1+0**

**MBB-692 Seminar II 1+0**

**MBB-699 Ph.D. Research 0+75**

# ENTOMOLOGY

## PROGRAMMES

**M.Sc. Entomology**
**Ph.D. Entomology**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of Specialization | Economic Entomology, Insect Ecology, Insect Physiology, Insect Taxonomy, Insect Toxicology, Biological Control, Apiculture |
| Core Courses | Ent.-501, Ent.-502, Ent.-503, Ent.-504, Ent.-505, Ent.-506, Ent.-508, Ent.-509/ Ent.-510 (either of Ent.-509 or Ent.-510), Ent.-519 |
| Minor Field | Agricultural Meteorology, Agronomy, Biochemistry, Botany, Microbiology, Molecular biology and Biotechnology, Chemistry, Nematology, Genetics and Plant Breeding, Plant Pathology, Statistics, Zoology or any other as approved by Dean, Postgraduate Studies (For Insect Physiology: Preferably Biochemistry and/ or Molecular Biology and Biotechnology; For Insect Toxicology: Preferably Chemistry and/ or Biochemistry) |
| Supporting Courses | Stat.-502 and courses from subject matter fields (other than Major and Minor) realting to area of special interest and research problems |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504. PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean Postgraduate Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Economic Entomology, Insect Ecology, Physiology, Insect Taxonomy, Insect Toxicology, Biological Control, Apiculture |
| Core Courses | Ent.-601, Ent.-602, Ent.-603, Ent.-605, Ent.-606 |
| Minor Field | Agricultural Meteorology, Agronomy, Biochemistry, Botany, Microbiology, Molecular Biology and Biotechnology, Chemistry, Nematology, Genetics and Plant Breeding, Plant Pathology, Statistics, Zoology or any other as approved by Dean, Postgraduate Studies |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problems |
| Deficiency Courses | As recommended by Student's Advisory Committee and approved by the Dean Postgraduate Studies |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Courses

**Ent. 51 Elementary Agricultural Entomology** **2+1** **Sem. I**

Insects, their distinguishing characteristics. Insects' dominance. Importance of insects in Agriculture. General body structure. Growth and development. Feeding stages and adaptations. Pests – definitions. Population build-up and causes of outbreak. Principles and methods of insect- pests management. Integrated Pest Management. Important insect-pests of crops - cereals, cotton, sugarcane, oilseeds, pulses, fruit and vegetables, nature of damage and management. Stored grain insect-pests and safe storage of grains. Insecticides classification and formulations. Safe use of insecticides. Plant protection equipment.

**Practical:** Insect's body structure and anatomy. Modifications of appendages. Development stages. Identification of important insect-pests of crops - cereals, cotton, sugarcane, oilseeds, pulses, fruit and vegetables, and symptoms of attack. Storage insect-pests and symptoms of damage. Working of commonly used plant protection equipment, common troubles and remedies. Insecticidal formulations. Preparation of spray fluid. Grain storage structures. Seed treatment and fumigation.

**Ent. 52 Useful Insects** **2+1** **Sem. II**

Insects of commercial importance. Apiculture, sericulture and lac culture. Pollinators. Predators, parasitoids and scavengers. Insects as food; Medicinal and aesthetic value of insects.

**Practical:** Identification of honey bee species and castes. Colony examination. Bee hive and equipment. Bee flora. Seasonal bee management. Colony multiplication. Bee enemies - identification, nature of damage and management. Bee diseases – symptoms and management. Bee products. Identification of silk worm species. Sericulture equipment. Silk worms' rearing. Pests and diseases of silk worms. Lac insect and lac culture. Bee pollinators. Important parasitoids and predators – identification and rearing. Insects' collection and display.

## Undergraduate Courses

**Ent. 201 Fundamentals of Entomology** **3+1** **Sem. I**

Definitions - Insect, Entomology; History of Entomology in India; Factors for dominance of Class Insecta in animal kingdom; Classification of phylum Arthropoda upto classes with examples and importance; Body segmentation, Structure of head, thorax and abdomen; Morphology - structure and functions of insect cuticle and molting; Structure and modifications of insect mouth parts, antennae, legs; Wing venation, modifications and wing coupling apparatus; Structure of male and female genital organs; Metamorphosis and diapause in insects; Types of larvae and pupae; Structure and functions of digestive, circulatory, excretory, respiratory, nervous, endocrine and reproductive system in insects; Types of reproduction in insects; Major sensory organs - simple and compound eyes, chemoreceptors; Insect Ecology - Introduction, environment and its components; Effect of abiotic factors - temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents; Effect of biotic factors - inter-specific competition (food, space, predation and parasitism) and intra-specific (food and space) competition; Insecticides - classification, toxicity and formulations.

Repellents, antifeedants, hormone analogues, attractants, gamma radiation; Taxonomy - importance, history and development and binomial nomenclature; Definitions - biotype, sub-species, species, genus, family and order; Classification of Class Insecta up to orders and suborders; Basic groups of present-day insects with special emphasis on orders and 48 families of Agricultural importance.

**Practical:** Collection and preservation of insects including immature stages; Morphology and anatomy of Grasshopper/Blister beetle; Different types of antennae, mouthparts, legs and wings; Wings venation and wing coupling apparatus; Types of larvae and pupae; Study of characters of orders - Odonata, Orthoptera, Dictyoptera, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance.

**Ent.-Pl.Path.202 Principles of Integrated Insect-pest and Disease Management 2+1 Sem. II**

Categories of insect pests and diseases. IPM - Introduction, history, importance, concepts, principles and tools. Economic importance of insect pests, diseases and pest risk analysis. Methods of detection and diagnosis of insect pests and diseases. Importance, calculation and dynamics of EIL and ETL. Methods of pest control - host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Recent technologies for pest management. Pesticides and their misuse; first aid and antidotes. Insecticides Act 1968. Spray technology. Ecological management of crop environment. Survey, surveillance and forecasting of insect pests and diseases. Development and validation of IPM module. Implementation and impact of IPM. IPM modules for insect pests and diseases. Safety issues in pesticide uses. Political, social and legal implications of IPM. Case histories of important IPM programmes.

**Practical:** Methods of diagnosis and detection of various insect pests and plant diseases. Sampling techniques for estimation of insect-pest and disease indices. Measurement of incidence of insect pests and diseases. Assessment of crop yield losses. Working out economics of IPM. Identification of biocontrol agents and natural enemies. Mass multiplication of Beauveria bassiana, Bacillus thuringiensis, Trichoderma, Pseudomonas, NPV and various parasitoids and predators. Pesticide appliances and their maintenance. Calculation of pesticide quantity for preparing spray material. Plan and assess preventive strategies (IPM module) and decision making. Monitoring of crop attacked by insect pests and diseases. Awareness campaign at farmers' fields.

**Ent.- Pl. Path. 203 Fundamentals of Crop Protection 2+1 Sem. I**

**(For B. Tech. Biotechnology Students)**

Insects- their general body structure and modifications. Importance of insects in agriculture. Insect metamorphosis and development stages. Insect diversity. Feeding stages of insects and kinds (modifications) of mouth parts. Concepts in population build-up of insects – GEP, DB, EIL, ETH and pest status. Categories of insect-pests. Causes of insect-pests outbreak. General symptoms of insects attack. Principles and methods of insect-pests management. Integrated Pest Management concept. Bioecology and management of important pests of major crops and storage products. Importance and scope of plant pathology. Concept of disease in plants. Nature and classification of plant diseases. Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites. Pathogenesis due to obligate and facultative parasites. Variability in plant pathogens. Conditions necessary for development of disease epidemics. Survival and dispersal of plant pathogens. Management of key diseases and nematodes of major crops.

**Practical:** Familiarization with generalized insect's body structure and appendages. Life stages. Acquaintance with insect diversity. Identification of important insect-pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains, and their symptoms of damage. Acquaintance with useful insects: predators, parasitoids, pollinators, honey bees and silk worms. Acquaintance to plant pathology laboratory equipment. Preparation of culture media for fungi and bacteria. Demonstration of Koch's postulates. Study of different groups of fungicides and antibiotics and methods of their evaluation. Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and their characteristic symptoms. Acquaintance with various pesticidal formulations. Principles and working of common plant protection appliances. Calculation for preparing spray material.

**Ent. 205 Basic Entomology 1+1 Sem. I**

**[For Students of B. Sc. (Hons.) Agribusiness Management]**

History of Entomology in India. Factors for insects' abundance and dominance in Animal kingdom. Classification of phylum Arthropoda up to classes. Relationship of class Insecta with other classes of Arthropoda. Body segmentation. Structure of head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs and wings. Structure of insect cuticle. Insect moulting. Metamorphosis and diapause in insects. Immature stages of insects. Structure and functions of digestive, circulatory, excretory, respiratory, nervous and reproductive systems in insects. Types of reproduction in insects. Major sensory organs. Systematics: Taxonomy importance of binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Newer classification of Insecta upto Orders. Population

dynamics, GEP, DB, EIL, ETL. Causes of insects' outbreaks. Principles and methods of insect- pests' management.

**Practical:** Methods of collection and preservation of insects including immature stages; Morphology of head, thorax, abdomen and appendages of Akk grasshopper; Modifications in insect antennae, mouthparts, legs and wings. Types of insect larvaeand pupae; Dissection of digestive and nervous system in insects; Dissection of male and female reproductive systems in insects; Study of characters of orders as per newer classification Orthoptera, Odonata, Dictyoptera, Phasmida, Thysanoptera, Hemiptera, Neuroptera, Lepidoptera, Coleoptera, Hymenoptera, Diptera. Insecticide formulations. Insecticide application equipments and calculations.

**Ent. 30l Pests of Crops and Stored Grains and their Management 2+l Sem. I**

**(For Students of B.Sc.(Hons.) Agriculture and B.Sc (Hons.) Agribusiness Management)**

Scientific name, order, family, host range, distribution, biology, ecology, nature of damage and management of majorarthropod pests of various field, vegetable, fruit, plantation and ornamental crops, and spices and condiments. Stored grain losses -role of physical, biological, mechanical and chemical factors. Insects, mites, rodents, birdsand microorganisms associated with stored grains and their management. Principles of grain store management. Storage structures and methods of grain storage. Warehousing Development and Regulatory Authority; Warehousing (Development and Regulation) Act.

**Practical:** Identification of life stages and damage symptoms, Study of seasonal history of insect pests offield crops, vegetable crops, fruit crops, ornamental crops, spices and condiments. Identification of insect- pests and mites associated with stored grains andtheir damage symptoms. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations of insecticide doses. Fumigation ofgrain store/godown. Identification of rodents and their control in godowns. Birds' identification and their management. Grain moisture measurement. Grain samplingmethods under storage conditions. Visit to godowns of Food Corporation of India and Central/ State Warehousing Corporation. Visit to field station of Indian Grain Storage Management and Research Institute (*IGMRI*).

**Ent. 302 Management of Beneficial Insects 2+1 Sem. II**

**(For B Sc.(Hons.) Agriculture, B Sc.(Hons.) Horticulture and B Sc.(Hons.) AgribusinessManagement**

Importance of beneficial insects. Beekeeping and its characteristic features. Bee species, castes and biology. Hive and apicultural equipment. Starting beekeeping. Bee pasturage. Seasonal management. Bee foraging and communication. Pests and diseases of honey bees and their management. Hive products and their production. Role of honey bees in crop pollination. Silkworm species, voltinism and biology. Rearing appliances of mulberry silkworm. Mulberry cultivation. Methods of harvesting and preservation of mulberry leaves. Silkworm rearing. Mounting and harvesting of cocoons. Pests and diseases of silkworms and their management. Lac insect – species, morphology, biology and host plants. Lac production – brood lac, stick lac, seed lac, button lac, shellac, lac-products. Important insect pollinators, weed killers and scavengers and their significance.

**Practical:** Identification of honey bee species and their combs. Identification of immature and mature stages of various castes of honey bees. Brood and food distribution in honey bee colony. Hive and beekeeping appliances. Examination of honey bee colonies. Seasonal management of honey bee colonies. Identification of bee enemies and diseases and their management. Bee pasturage, foraging and communication. Honey extraction, processing and packaging. Collection of other hive products. Identification of silkworm species. Biology of silkworm. Silkworm rearing appliances. Methods of harvesting and preservation of mulberry leaves. Biology and host plants of lac insect. Identification of important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture and lac culture

**Ent. 303 Insect-pests of Horticultural Crops and their Management 2+1 Sem. I**

**[For Students of B.Sc. (Hons.) Horticulture]**

Classification of insect-pests. Dynamics of EIL and ETL. Methods of pest control-host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Recent technologies for insect

pest management. Insecticides- classification, formulation, first aid and antidotes. IPM – importance and principles. Scientific name, order, family, host range, distribution, biology, ecology, nature of damage and management of important insect-pests of various fruits (tropical, sub-tropical and temperate), vegetables, ornamental, plantation, spice, medicinal, aromatic crops and under protected conditions. Pest surveillance, storage insects - Scientific name, order, family, host range, distribution, biology, ecology, nature of damage and management of important insect-pests attacking stored fruit, vegetable, ornamental, plantation, spice, medicinal, aromatic crops' produce and their processed products. Insecticide residue problems in fruit, vegetable, plantation, spice, medicinal and aromatic crops and their maximum residue limits (MRLs). Waiting periods for insecticides on various crops.

**Practical:** Identification of important insect-pests of various fruits (tropical, sub-tropical and temperate), vegetables, ornamental, plantation, spice, medicinal, aromatic crops in field and their produce during storage and their symptoms of damage. Identification of biocontrol agents and natural enemies. Insecticide formulations. Pesticide application appliances. Calculation of insecticide quantity for preparing spray material.

**Ent. 491 Agro-industrial Attachment** **0+4** **Sem. I**

Commercial Honey Production, Hive and Apicultural Equipment and Honey Processing Manufacturing Units; Honey Trading, Processing, Packaging, Exporting and Marketing Units.

**Ent.-Pl. Path. 491 Agro-industrial Attachment** **0+4** **Sem. I**

Pesticide and Biopesticide Industries

Biocontrol Agents Production Units

Plant Quarantine Station

Virus free Potato Tuber Production Units

**Ent. 492 Experiential Learning in Commercial Apiculture** **0+20** **Sem. I**

**Ent.-Pl.Path.492 Experiential Learning in Production Technology for Bioagents** **0+20** **Sem. II**

## Postgraduate Courses

**Ent.-501 Insect Morphology** **2+1** **Sem. 1**

**Unit I** External Morphology: Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. Head- Origin, structure and modification; mouthparts, antennae, their types and functioning; tentorium and neck sclerites. Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; legs: structure and modifications. Abdomen- Segmentation and appendages; genitalia and their modifications; embryonic and post-embryonic development.

**Unit II** Insect sense organs (mechano-, photo-and chemo-receptors); organogenensis at pupal stage; insect defense; chaetotaxy; morphological traits in relation to forensic entomology.

**Unit III** Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects. Comparative study of life history strategies in hemimetabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

**Practical:** Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia; dissection of genitalia.

Types of immature stages in insects, their collection, rearing and preservation. Identification of immature insects to orders and families, in endopterygote orders viz. , Diptera, Lepidoptera, Hymenoptera and Coleoptera using key. Detailed and finer morphological studies in some diverse representative categories of insects.

**Ent.-502 Insect Anatomy and Physiology** **2+1 Sem. 1**

**Unit I** Anatomy of generalized insect; scope and importance of insect physiology; physiology of integument, moulting, chemistry of cuticle, biosysthesis of chitin; growth, hormonal control, metamorphosis and diapause; pheromone secretion, transmission, perception and reception.

**Unit II** Physiology and mechanism of digestion, circulation, respiration, excretion, reproduction, secretion (exocrine & endocrine glands) and nerve impulse transmission in insects. Insect metabolism and energy transfer. Biochemical and molecular regulation. Bioluminescence mechanisms.

**Unit I**II Importance of insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellularmicroorganisms and their role in physiology; artificial diets.

**Practical:** Dissections for anatomy including microtomy for tissues; latest analytical techniquesfor analysis of free amino acids of haemolymph; isolation, purification and activity evaluation of metabolic enzymes, determination of chitin in insect cuticle; examination and count of insect haemocytes; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets. Techniques in respiration estimation.

**Ent.-503 Insect Taxonomy** **1+2 Sem. 1**

**Unit I** History of insect classification; principles of systematics and its importance. Identification, purpose, methods character matrix, taxonomic keys. Type specimens and categories. Descriptions-subjects of descriptions, characters, nature of characters, analogy v/s homology, parallel v/s convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism. Timelines (eons) of evolutionary history of life and insects. Biogeography and biogeography realms. Introduction to phylogeny of insects. International Code of Zoological Nomenclature,Principles of bionomial nomenclature. Phylocode, its brief explanation and uses. Process of speciation and interbreeding; sympatric, allopatric species. Molecular systematics, DNA barcoding, karyological and biochemical approaches in taxonomy. Insect labeling protocols and procedures.

**Unit II** Modern classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- and the Orders contained. Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them. Modern insect classification. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

**Unit III** Distinguishing characters, general biology, habits and habitats of insect orders andeconomically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

**Practical :** Study of Orders of insects as per new classification and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Hemiptera, Thysanoptera, Phthiraptera,Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

**Ent.-504 Insect Ecology** **2+1 Sem. II**

**Unit I** History and definition. Organisation of the biological world. Concepts of species, populations, ecosystems, biomes, biosphere, geographical range, endemism, geographical realms. Biodiversity hotspots, characteristics, status at global and national level. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects-

Law of the Minimum,Law of Tolerance, and biocoenosis, Systems approach to ecology.

**Unit II** Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Casestudies of insect life tables. Population dynamics. Factors affecting abundance- Environmental factors, dispersal and migration, seasonality in insects. Classification and mechanisms of achieving different seasonality-Diapause (Quiescence), aestivation, hibernation.

**Unit III** Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional ecology. Food chain-web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions-Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterramodel, Concept of niche ecological homologues, competitive exclusion. Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

**Unit IV** Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's d/w, Relationbetween the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms,Concept of diversity- the Wallacian view. Assessment of diversity. Diversity-stability debate, relevance to pestmanagement. Pest management as applied ecology. Climate change and insect pest/ natural enemy population;ecological engineering.

**Practical :** Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey- predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of diversity indices-Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

**Ent.-505 Biological Control of Insect-Pests and Weeds** **2+1** **Sem. 1**

**Unit I** History, principles and scope of biological control; important groups of parasitoids,predators and pathogens. Techniques of biological control classical biological control, augmentation and conservation. History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

**Unit II** Biology, adaptation, host seeking behaviour of predatory and parasitic groups ofinsects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects. Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

**Unit III** Mass production of quality bio-control agents- techniques, formulations, economics, field release/application and evaluation. Development of insectaries, their maintenance.

**Unit IV** Successful biological control projects in India. Analysis, trends and future possibilities of biological control. Importation of natural enemies- quarantine regulations. Biotechnology in biological control; paratransgenecis. Semiochemicals in biological control.

**Practical :** Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval pupal and pupal parasitoids, commonpredators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standardsfor biocontrol agents.

**Ent.-506 Toxicology of Insecticides** **2+1** **Sem. I**

**Unit I** Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

**Unit II** Classification of insecticides and acaricides based on mode of entry, detailed mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiaryamines, neonicotinoids, oxadiazines, phenyl pyrazoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nanopesticides; drawbacks of insecticide abuse.

**Unit III** Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides-synergism, potentiationand antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. Bioassay definition, objectives, criteria, factors, problems and solutions.

**Unit IV** Insecticide metabolism; insect-pest resistance to insecticides; IRAC, mechanisms and types of resistance; molecular assessment of resistance; insecticide resistance management and pest resurgence.

**Unit V** Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis. Waiting periods, MRLs – establishing thereof. Insecticide Act, registration procedures, label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

**Practical :** Insecticide formulations and mixtures; Working out doses and concentrations of pesticides for laboratory and field evaluation for their bio-efficacy; bioassay techniques; probit analysis; procedures for assessing insecticide resistance, determination of discriminating dose; determining molecular basis of insecticide resisitance; evaluation of insecticide toxicity. Assessment of field and laboratory toxicity of insecticides to beneficial insects. Pesticide appliances. Modern analytical procedures for pesticide residue analysis. Determination of waiting periods and MRLs.

**Ent.-507 Host Plant Resistance** **2+1** **Sem. II**

**Unit I** History and importance of resistance; principles, classification, components, types and mechanisms of resistance.

**Unit II** Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

**Unit III** Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

**Unit IV** Factors affecting plant resistance including biotypes and measures to combat them.

**Unit V** Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world, uses and sources and resistance.

**Unit VI** Role of biotechnology in plant resistance to insects.

**Practical :** Screening techniques for measuring resistance; measurement of plant characters and working out their correlations with plant resistance; testing of resistance in important crops; bioassay of plant extracts of susceptible/resistant varieties; demonstration of antibiosis, tolerance and antixenosis.

**Ent.-508 Concepts of Integrated Pest Management** **2+0** **Sem. II**

**Unit I** History, origin, definition and evolution of various terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons.

**Unit II** Concept and philosophy, ecological principles, economic threshold concept and economic consideration. Insect host plant relationships; theories and basis of host plant selection in phytophagous insects.

**Unit III** Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods,

factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

**Unit IV** Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

**Ent.-509 Pests of Field Crops** **2+1** **Sem. 1**

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. Insect pest scenario in relation to climate change.

**Unit I** Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.). Insect pests of cereals and millets and their management.

**Unit II** Insect pests of pulses, oilseeds and their management.

**Unit III** Insect pests of fibre crops, forage crops, sugarcane and their management.

**Practical :** Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

**Ent.-510 Pests of Horticultural and Plantation Crops** **2+1** **Sem. 1**

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

**Unit I** Fruit crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, ber, fig, citrus, aonla, pineapple, apple, peach and other temperate fruits.

**Unit II** Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, French beans, brinjal, okra, allgourds, leafy vegetables, etc.

**Unit III** Plantation crops - coffee, tea, rubber, coconut, arecanut, cashew, cocoa, etc. ; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine, etc.

**Unit IV** Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation.

**Practical :** Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non-insect pests.

**Ent.-511 Post Harvest Entomology** **1+1** **Sem. II**

**Unit I** Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses in toto vis-à-vis total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Concept of seed vault.

**Unit II** Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

**Unit III** Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities.

Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage-types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

**Unit IV** Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Insecticide resistance in stored product pests and its management; recent advances (MAS, PPP, HS) in storage pest management; integrated approaches to stored grain pest management.

**Practical :** Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of hidden insect infestation in stored food grains; estimation of uric acid content in infested produce; estimation of losses in stored food grains; determination of moisture content in stored foodgrains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, Hapur, etc. (only where logistically feasible).

**Ent.-512 Insect Vectors of Plant Pathogens** **1+1** **Sem. II**

**Unit I** History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

**Unit II** Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

**Unit III** Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

**Unit IV** Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

**Unit V** Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

**Practical :** Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies. Vector rearing and maintenance; estimating vector transmission efficiency, studying vector-virus host interaction.

**Ent.-513 Principles of Acarology** **1+1** **Sem. II**

## Theory

**Unit I** History of Acarology; importance of mites as a group; habitat, collection and preservation of mites. Soil mites and their classification, habitats and their identification.

**Unit II** Introduction to morphology and biology of mites and ticks. Broad classification-major orders and important families of Acari including diagnostic characteristics. Estimation of populations; sampling and extraction methods for soil mites

**Unit III** Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees. Management of mites using botanicals, safer acaricides, phytoseiid predators, fungal pathogens etc. Culturing of phytophagous, and predatory mites. Mode of action of acaricides, resistance of mites and ticks to acaricides, its management.

**Practical :** Collection of mites from plants, soil and animals; extraction of mites from soil, plants and stored products; preparation of mounting media and slide mounts; external morphology of mites; identification of mites up to family level using keys; studying different rearing techniques for mites.

**Ent.-514 Vertebrate Pest Management** **1+1** **Sem. II**

**Unit I** Introduction to vertebrate pests of different crops; biology of vertebrate pests such as rodents, birds and other mammals.

**Unit II** Bio-ecology of birds of agricultural importance, patterns of pest damage and assessment, roosting and nesting systems in birds; management of pestiferous birds; conservation of predatory birds.

**Unit III** Bio-ecology of rodents of agricultural importance, patterns of pest damage andassessment, burrowing pattern and habitat of rodents; management of pestiferous rodents.

**Unit IV** Bio-ecology of higher vertebrates of agricultural importance, patterns of damage andassessment, their habitat; management of pestiferous vertebrates.

**Unit V** Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites), cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods, Operational practices- baiting, equipments and educative programmes.

**Practical :** Identification of important rodents, birds and other vertebrate pests of agriculture, food preference and hoarding, social behaviour, damage assessment, field survey, population estimation, management strategies: preventive and curative methods.

**Ent.-515 Techniques in Plant Protection** **0+1** **Sem. II**

**Unit I** Pest control equipment, principles, operation, maintenance, selection, and application of pesticides; release of bio-control agents; seed dressing, soaking, root- dip treatment, dusting, spraying, and pesticide application through irrigation water; application of drones in plant protection, SOPs and other requirements.

**Unit II** Soil sterilization, solarization, deep ploughing, flooding, techniques to check thespread of pests through seed, bulbs, corms, cuttings and cut flowers.

**Unit III** Uses of light, transmission and scanning electron microscopy.

**Unit IV** Protein isolation from the pest and host plant and its quantification usingspectrophotometer and molecular weight determination using SDS/PAGE.

**Unit V** Use of tissue culture techniques in plant protection. Computer application for predicting/ forecasting pest attack and identification Decision Support System.

**Ent.-516 Apiculture** **2+1** **Sem. I**

**Unit I** Historical development of apiculture at global level and in India, Nobel Laureateson honey bees and their contribution, World Bee Day; Classification of bees; *Apis* species and their global distribution; Morphology and anatomy of honey bee; Honey bee biology, physiology, ecology, adaptations; Honey bee behaviour – nest founding, comb construction, brood care, defense, other in-house and foraging activities; Bee pheromones; Honey bee communication

**Unit II** Commercial beekeeping as an enterprise; Design and use of bee hives; Apiculturalequipment; Seasonal bee husbandry; Honey bee nutrition and artificial diets; Absconding, swarming, drifting – causes and management; Curbing drone rearing; Laying worker menace – causes, signs and management

**Unit III** Bee genetics; Principles and procedures of bee breeding; Screening of honeybee colonies; Techniques in mass queen bee rearing; Mating nuclei and their establishment; Selective mating; Queen bee management; Bee packages

**Unit IV** Ectoparasitic and endoparasitic bee mites – biology, ecology, nature and symptoms of damage, management tactics; Wax moths, wasps and ants - biology, ecology, nature and symptoms of damage, management tactics; Predatory birds, their damagepotential and management tactics; Pesticide poisoning to honey bees, signs and protection; Protocols in evaluation of pesticide toxicity to honey bees

**Unit V** Honey – composition, properties, crystallization, post-harvest handling and processing; Honey quality standards and assessment; Apicultural diversification – potential and profitability; Production/ collection of bee pollen, propolis, royal jelly, bee venom and bees wax and their post-harvest handling; honey production potential of crops; Apitherapy; Value addition of hive products; Development of apiculture project

**Unit VI** Cross-pollination, necessities, pollination types and terms, agent-wise pollination classification; Non-Apis pollinators, their augmentation and conservation; Role of bee pollinators in augmenting crop productivity; Managed bee pollination of crops; pollination requirement of crops.

**Practical :** Morphological characteristics of honey bee; mouthparts; digestive, respiratory and reproductive adaptations in different castes of honey bees; recording of colony performance; seasonal bee husbandry practices; swarming, queenlessness, laying workers menaces, etc. & their remedies; innovative techniques in mass queenbee rearing, establishment of mating nuclei; selection and breeding of honey bees; instrumental insemination; formulation of artificial diets and their feeding; production technologies for various hive products; bee enemies and diseases and their management; estimation of honey production potential; recording pollination efficiency; application of various models for determining pollination requirement of crop; developing a beekeeping project.

**Ent.-517 Sericulture** **2+1** **Sem. I**

**Unit I** History of sericulture, importance, organizations involved in sericulture activities. Silkworm types, distribution, area and silk production.

**Unit II** Mulberry species, ecological requirements, cultivation, improved varieties, propagation methods, sapling production, planting and pruning techniques, pest and diseases and management strategies, intercropping, water and weed management. Food plants of eri silkworm, castor cultivation, inter-cultural operations, nutrient and water management; method of harvest. Host plants of Tasar silkworm, nursery and cultivation, selection of seed, soaking and heap making, pruning techniques. Food plants of Muga silkworm, Som and Soalu propagation methods, nursery techniques, inter-cultural operations and weed management.

**Unit III** Silkworm origin – classification based on voltinism, moultinism, geographical distribution and genetic nature –pure races –Multivoltine and bivoltine races, cross breeds, bivoltine hybrids. Races and hybrids of mulberry, eri, tasar and muga silkworms. Morphology and biology of silkworm species, sex limited characters. Anatomy of digestive and excretory systems of larva, structure and function of silk glands.

**Unit IV** Rearing house, types, disinfection, room and bed disinfectants. Egg incubation methods. Chawki rearing, feeding, cleaning and spacing .Rearing of late age worms, feeding, cleaning, spacing and moulting care. Mountages, cocoon harvesting and marketing. Pests and diseases of silkworms and their management.

**Unit V** Post cocoon technology, stifling, cocoon cooking, brushing, reeling, re-reeling, bleaching, degumming, dyeing, printing and weaving, different reeling machines. Value addition in sericulture; economics of sericulture.

**Practical :** Morphology of mulberry plants. Identification of popular mulberry genotypes, nursery bed and main field preparation, planting methods, identification of nutrient deficiency symptoms, identification of weeds, pruning and harvesting methods, identification of pests and diseases of mulberry. Morphology of silkworm. Identification of silkworm races. Dissection of mouth parts and silk glands. Disinfection techniques. Rearing facilities and infrastructure. Silkworm rearing, feeding, cleaning and spacing. Identification of pests and diseases of mulberry silkworm, hyperparasitoids and mass multiplication techniques. Silkworm egg production technology. Tasar, Eri and muga silkworms – rearing methods. Pests and diseases of non-mulberry silkworms. Visit to grainage, cocoon market and silk rearing and reeling centre. Economics of silkworm rearing.

**Ent.-518 Lac Culture** **2+1** **Sem. I**

**Unit I** History of lac production, importance, potential of lac production in India. Organizations involved in lac production activities. Strains of lac insects and lac crops – distribution, area and production of different strains of lac.

**Unit II** Steps and operation of lac production. Lac host plant species, ecological requirements, their cultivation, seasons of host plants, harvest time of host plants, rearing seasons; grouping of host trees, pruning methods and timing. Lac host plant pests and diseases, management strategies.

**Unit III** Basic morphology and taxonomy of lac insect. Species diversity and distribution. Strains of lac insect and their characteristics. Biology of lac insect.

**Unit IV** Lac insect-host plant interaction. Selection of brood lac, local practices, improvedalternatives, coupe system. Propagation of lac insects: natural self inoculation,artificial inoculation. Inoculation process and duration. Removal of phunki, harvesting of lac, immature harvesting, mature harvesting and time of harvesting. Predators and parasitoids of lac insect, hyperparasites, diseases and their management.

**Unit V** Lac production stages. Factors affecting yield and quality of shellac. Host plants (kusum, palas, ber,pigeonpea, Flemingia sppsemialata). Technology of brood preserving. Host-specific technologies -cultivation on specific host plants. Integration of lac cultivation with agro-forestry and horticulture. Composition of lac. Socio- economic potential of lac. export-import of lac and lac products. Marketing of lac and its products. Lac processing and value addition. Entrepreneurship development.

**Practical :** Lac host cultivation. Lac production practices. Equipment for lac production. Conventional and advanced methods. Coupe system of lac production. Cultivation of suitable host plants. Pruning of host trees. Herbarium of host plants. Strains of lac insects. Brood lac selection and treatment for pest management. Life cycle study. Slide preparation of adult and immature stages. Inoculation of host trees. Identification of natural enemies of lac insect and their management. Molecular characterization of lac insect. Lac harvesting .Process of manufacture of seedlac and shellac from stick lac. Grading of seed lac and shellac. Marketing of lac products and by-products

**Ent.-519 Biotechnological Approaches in Entomology 2+1 Sem. II**

**Unit I** Introduction to molecular biology, tools used in molecular biology.

**Unit II** DNA recombinant technology, identification of genes/nucleotide sequences for traits of interest.

**Unit III** Genes of interest in entomological research- Introduction to Insect omics, marker genes for sex identification, peptides and neuropeptides, JH esterase,chitinase, Plant-derived enzyme inhibitors, protease inhibitors, trypsin inhibitors, α-amylase inhibitors, lectins, genes of non-plant origin, *Bacillus thuringiensis* endotoxins, modeof action of cry genes, synthetic Bt toxin genes, Other toxin genes, genes derived from entomophagous viruses, transgenic plants for pest resistance.

**Unit IV** Genetically engineered microbes and parasitoids in biological control agents-Genetic engineering in baculoviruses and fungal biocontrol agents for greater efficacy againstinsect pests. Genetic improvement of predators/parasitoids, etc.

**Unit V** Genetic-based methods for agricultural insect pest management. Molecular tools fortaxonomy and phylogeny of insect-pests, insect pest management through sterile insect technique and release of insects carrying a dominant lethal gene. Effects of transgenic plants on pest biology and development, resistance management strategies in transgenic crops, molecular mechanism of insecticide resistance. Methods and application of insect trangenesis, transgenics in silkworm and honeybees. Molecular tools for taxonomy and phylogeny of insect pests, DNA-based diagnostics, RNAi andgenome editing (CRISPR/Cas9) for insect pests, Nano technology and its application, Biosafety related issues in molecular entomology.

**Practical :** Isolation of DNA/RNA; agarose gel electrophoresis of DNA, quantification of DNA by spectrophotometirc and agarose gel analysis, PCR amplification of mitochondrial cytochrome oxidase sub**Unit I** gene (cox1) and 16S rRNA gene, cloning of PCR amplicons in standard plasmid vectors for sequencing, confirmation of the insert, miniprep of recombinant plasmid DNA, Transformation, BLAST analysis and multiplesequence alignment of the sequence with sequences already available in GenBank and phylogenetic analysis; SDS-PAGE of the isolated proteins.

**Ent.-520 Plant Quarantine, Bio-Safety and Bio-Security 2+0 Sem. II**

**Unit I** Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine –domestic and international. Quarantine restrictions in themovement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

**Unit II** Plant protection organization in India. Acts related to registration of pesticides,biostimulants and transgenics. Insecticide regulatory bodies, synthetic insecticides, bio-pesticides,pheromone and

biostimulant registration procdures. Historyofquarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration;APEDA. IUCN. Biodiversity Act. Import and Export of bio-control agents and for systemaitcis/ taxonomic studies, regulations and procedures. Biodiversity hotspots, characteristics, the hotspots in India.

**Unit III** Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and theire limination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

**Unit IV** WTO regulations; non-tariff barriers; pest risk analysis, good laboratory practicesfor pesticide laboratories; pesticide industry; sanitary and phytosanitary measures. Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity. Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, issues related to release of genetically modified crops.

**Ent.-521 Edible and Therapeutic Insects** **1+1** **Sem. I**

**Unit I** Edible and therapeutic insects: the concept, definition, and importance.

**Unit II** History and origin of insects as food, feed and medication; important insect speciesand insect products consumed.

**Unit- III** Edible insect ecology, conservation and management of edible insect resources;environmental opportunities of insect rearing.

**Unit- IV** Nutritional composition and role of insects in food security

**Unit V** Insect farming: the concept, definitions, and rearing techniques.

**Unit VI** Primary and secondary processing of edible insects for food and feed

**Unit VII** Food safety and preservation, edible insects for livelihood security

**Practical :** Survey and identification of edible and therapeutic insect species. Collection and preservation of edible and therapeutic insect specimens. Rearing techniques of edible insect species. Harvesting techniques of edible insects from natural environment. Edible insect products collection/ extraction. Preparation of food recipes. Analysis ofproximate elemental composition. Antioxidant and anti-nutritional properties and microbial aspects of preservation.

**Ent.-522 Medical and Veterinary Entomology** **1+1** **Sem. I**

**Unit I** Introduction to medical, veterinary and forensic entomology; Classification of Arthropod-bornediseases; Hematophagy, disease transmission and epidemiology; flies (Diptera) of medical andveterinary Importance; moth flies: Leishmaniasis and Bartonellosis; biting midges (Ceratapogonidae).

**Unit II** Mosquito taxonomy, biology, and behavior; mosquito viruses: EEE, VEE, SLE, yellow fever,mosquito surveillance; malaria; horse flies, deer flies: EIA, anaplasmosis; muscid flies; Myiasis (Muscoidea); myiasis and louse flies; black flies of medical and veterinary Importance; filariasis: mansonellosis, onchocerciasis.

**Unit III** Lice of medical and veterinary importance; rickettsial diseases: epidemic typhus,etc. ; mites: rickettsialpox; mites and acariasis: mange, scabies, chiggers; spiders andscorpions; fleas (Siphonaptera) ofmedical and veterinary importance; plague and murine typhus

**Unit IV** Ticks of medical and veterinary importance; lyme disease, rocky mountain spotted fever, tularemia;true bugs (Hemiptera): kissing bugs and bedbugs; chagas disease; tsetse flies; Lepidoptera and Hymenoptera of medical and veterinary importance.

**Practical :** Identification of arthropod Classes, Orders and Families of medical and veterinary importance;collection, segregation, curing insect and arachnid specimens, their preservation; management of insect and mite pests of medical and veterinary importance; study of some Practical aspects in forensic entomology.

**Ent.-523 Forest Entomology** **1+1** **Sem. I**

**Unit I** History of tropical forest entomology, diversity of forest insects: structural and functional diversity – the feeding guilds, concept of pests, ecology of insects in forest environment, concept and functioning of ecosystem, role of insects in ecosystem processes of tropical forests: insects as primary consumers, secondary and tertiary consumers, as decomposers, as food, pollinators and other ecological interactions.

**Unit II** Insect pests in natural forests, general pest incidence, pest outbreaks: Lepidoptera, Coleoptera, Hemiptera, and Hymenoptera: their biology, seasonal history and management; insect pests in plantations, nursery pests, sapling pests, pests of older plantations and their impact;insect pests of stored timber, categories of wood destroying insects and their damage: termites and beetles.

**Unit III** Population dynamics, characteristics of population growth, factors affection population growth, principles governing population dynamics, types and causes of forest insect outbreaks; general issues in forest entomology: enemies' hypothesis, resource concentration hypothesis, pest evolution hypothesis; pest problems in plantations of indigenous vs exotic species; pest problems in monocultures vs mixed plantations.

**Unit IV** Management of tropical forest insect pests, historical development and present status of tropical forest pest management, overview of pest management options: preventive measures, remedial measures; unique features of forest pest management; constraints to forest pest management in the tropics; guidelines for the practice of forest pest management in the tropics

**Unit V** Insect pests in plantations: Location-specific case studies.

**Practical :** Collection, identification and preservation of important insect pest specimens of forest plants and some damage material; detection of insect infestation and assessment of losses due to insect pests; habitat management for vertebrate and insects pests; Familiarization with the meteorological and plant-protection equipment, application of pesticides and bio-control agents in the management of insect pests in nurseries and plantations,

**Ent.-591 Seminar** **1+0**

**Ent.-599 Master's Research** **0+30**

**Ph.D. courses**

**Ent.-601 Insect Phylogeny and Systematics** **1+2** **Sem. II**

**Unit I** Detailed study of three schools of classification- numerical, evolutionary and cladistic. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms and pylogenetic studies. Methods in identification of homology. Species concepts, speciation processes and evidences. Zoogeography and biogeographical realms.

**Unit II** Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Evolution of life, fossil insects and and insect diversity over geological eons/ eras.

**Unit III** Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN; scientific ethics. Nomenclature and documentation principles, protocols and procedures; protocols for report preparation on new species; various categories of type specimens, depositionof holotypes, paratypes, and insect specimens as a whole in national and international repositories – requirements and procedures. Role of IUCN.

**Unit IV** Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, works on revision of taxa, monographs,check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular taxonomy, barcoding species and the progress made in molecular sytematics.

**Practical :** Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study ofcharacters, development of character table, and construction of taxonomic keys for the selected group. Development of descriptions, photographing, writing, diagrams, and preparation of specimens for

'type like' preservation. Submission of the collections made of the group. Multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarization for developing cladograms and use of modern computer programmes to develop cladograms.

**Ent.-602 Insect Physiology and Nutrition** **2+1** **Sem. II**

**Unit I** Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, hardening of cuticlde.

**Unit II** Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development. Sugars' toxicity, anti-metabolites. Absorption and utilization of different nutrients - processes and pathways. Physiology of excretion and osmoregulation, water conservation mechanisms.

**Unit III** Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semi chemicals in insect life, toxins and defense mechanisms.

**Unit IV** Endocrine system and insect hormones, physiology of insect growth and development-metamorphosis, polymorphism and diapause. Bioluminescence in fireflies – cellular processes and chemical mechanisms.Insect behaviour in IPM,Concept of super- normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals inpest management. Biochemical and molecular regulation of life processes.

**Practical :** Preparation of synthetic diets for different groups of insects; rearing of insects on synthetic, semisynthetic and natural diets; determination of co-efficient of utilization; qualitative and quantitative profileof bio-molecules: practicing analytical techniques for analysis of free amino acids of haemolymph; zymogram analyses of amylase; determination of chitin in insect cuticle; examination and count of insect haemocytes.

**Ent.-603 Insect Ecology and Diversity** **2+1** **Sem. I**

**Unit I** Characterization of distribution of insects- Indices of Dispersion, Taylor's Power law. Island Biogeography and realms. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-PreyModels- Lotka-Volterra and Nicholson-Bailey Model.

**Unit II** Insect Plant Interactions. Fig-fig wasp mutualism and a quantitative view of types ofassociations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes ofinsect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses. Host seeking behavior of parasitoids.

**Unit III** Biodiversity and Conservation- RET species, Ecological indicators. Principles of population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging Theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, nutritional ecology.

**Unit IV** Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies – timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs natural ecosystems –characterisation, pest control as applied ecology- case studies.

**Practical :** Methods of data collection under field conditions. Assessment of distribution parameters, Taylor's power law,Iwao's patchiness index, Index of Dispersion, etc. Calculation of sample sizes by different methods. Fitting Poisson and Negative Binomial distributions and working out the data transformation methods. Hardy- Weinberg Law, Computation of Allelic and Phenotypic Frequencies – Calculation of changes under selection, Demonstration of genetic drift. Assessment of Patch Departure

rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/Goniozus/ Female Bruchids, etc.- a test of reproductive effortand fitness. Construction of Life tables and application of Leslie Matrix – populationprojections, Stable age distribution. Exercises in development of Algorithms for cropmodeling.

**Ent.-604 Insect Behaviour** **1+1 Sem. I**

**Unit I** Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behavior, inducted behavior, learnt behavior and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behavior- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

**Unit II** Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specificcommunication, use of signals in defense, mimicry, polyphenism; evolution of signals.

**Unit III** Reproductive behavior- mate finding, courtship, territoriality, parental care, parentalinvestment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self organization and insect behavior.

**Unit IV** Foraging- Role of different signals in host searching (plant and insects) and hostacceptance, ovipositional behavior, pollination behavior,navigation and memory,co- evolution of plants and insect pollinators. Activity rhythms and biological clocks. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semiochemicals, auditory stimuli and visual signals in pest management.

**Unit V** Insect societies, Principles, forms, classification-general and for bees; nest searching, founding and construction behaviour, brood care behaviour, defense and caste determination behaviour in social insects

**Practical :** Quantitative methods in sampling behavior; techniques in training bees to artificial feeders; olfactory response to stimuli inbees; sensory adaptation and habituation in a fly or butterfly model;communication for direction and distance of food source byhoney bees; physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer); colour discrimination in honey bee or butterfly model; evaluating learning and memory in bees; role of self-organization in resource tracking by honey bees; use of ethovision and antennogram; evaluation of different types of traps against fruit flies with respect to signals; use of honey bees/Helicoverpa armigera to understandbehavioural polymorphism with respect to learning and response to pheromone mixtures;hygieneand defense traits in honey bees.

**Ent.-605 Bio-Inputs for Pest Management** **2+1 Sem. II**

**Unit I** Scope of classical biological control and augmentative bio-control; introduction and handling of natural enemies;nutrition of entomophagous insects and their hosts, dynamics of bio-agents vis-à-vis target pest populations.

**Unit II** Bio-inputs: mass production of bio-pesticides, mass culturing techniques of bio- agents, insectary facilities and equipments, basic standards of insectary, viable mass- production unit, designs, precautions, good insectary practices.

**Unit III** Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of bio-control agents, bankable project preparation.

**Unit IV** Scope of genetically engineered microbes and parasitoids in biological control,Paratransgenesis of ideal traits in biocontrol agents for introgressing and for progenyselections, breeding techniques of bio-control agents.

**Practical :** Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides

on natural enemies; effect of semiochemicals on natural enemies, breeding of various bio-control agents, performance of efficiency analyses ontargetpests; project document preparation for establishing a viable mass-production unit /insectary; observation of feeding behavior acts of predatory bugs/ beetles.

**Ent.-606 Insecticide Toxicology and Residues** **2+1** **Sem. II**

**Unit I** Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Impact of herbicides on insects. Detailed modes of action of newer insecticide molecules; developments in bio-rational approaches; SPLAT;RNAi technology for pest management.

**Unit II** Biochemical, molecularand physiological target sites of insecticides in insects;developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism ofinsecticides.

**Unit III** Joint action of insecticides; activation, synergism and potentiation.

**Unit IV** Problems associated with pesticide use in agriculture: pesticide resistance; details ofresistance mechanisms, biochemical and genetic alterations,resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazardsand other side effects.

**Unit V** Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation – at national and global level; bound and conjugated residues, effect on soil fauna, flora and fertility. Latest techcniques in residues estimation. Waiting periods. Microbial remediation ofpesticides. Insecticide laws and standards, and good agricultural practices.

**Practical :** Residue sampling, extraction, clean-up and estimation of insecticide residues by various methods; hands-on working with latest analytical technologies in pesticide resideues estimation; calculations and interpretation of data; working out waiting periods; estimation of MRLs; biochemical, biological and molecular techniques for detection of insecticide resistance in insects; preparation of EC formulation using neem oil.

**Ent.-607 Plant Resistance to Insects** **1+1** **Sem. I**

**Unit I** Importance of plant resistance, historical perspective, desirable morphological,anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host-plant factors.

**Unit II** Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyljasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance;exogenous application of elicitors.

**Unit III** Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker- aided selection in resistance breeding; horizontal gene transfer (natural) from plantsinto insects- a case study.

**Unit IV** Estimation of plant resistance based on plant damage- screening and damage rating;evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties. Development of resistance in Pink Bollworm against BGII cotton – a case study.

**Practical :** Understanding mechanisms of resistance for orientation, feeding, oviposition etc. , allelochemical bases of insect resistance; macro-culturing of test insects like aphids, leaf/plant hoppers, mites and stored grain pests; field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; determination of antixenosis index, antibiosis index, tolerance index, plant resistance index. Studying resistance in PBW against BGII cotton.

**Ent.-608 Acarology** **1+1** **Sem. I**

**Unit I** Comparative morphology of Acari, phylogeny of higher categories in mites and ticks, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly

occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae,Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae. Soilmites in India.

**Unit II** Management of economically important species of mites in agriculture, veterinary and public health; storage acarology.

**Unit III** Mites as vectors of plant pathogens. Mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites.

**Unit IV** Predatory mites, their mass production and utilization in managing mite pests. Acaropathogenic fungi identification, isolation and utilization.

**Practical :** Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their rolein suppression of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens,etc.

**Ent.-609 Molecular Entomology** **1+1** **Sem. I**

**Unit I** Introduction to molecular biology; techniques used DNA recombinant technology.

**Unit II** DNA and RNA analysis in insects- transcription and translocation mechanisms. Insect omics, identification of genes/nucleotide sequences for characters of interest. Marker genes for sex identification, neuropeptides, JH esterase,chitinase, CPTI; lectins and proteases.

**Unit III** Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, Bt and entomopathogenic fungi. Transgenic plants for pest resistance.

**Unit IV** Insect gene transformation; biotechnology in relation to silkworms and honey bees. DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.

**Unit V** DNA-based diagnostics. Molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; molecular mechanisms of insecticide resistance/cry toxins resistance. Resistance management strategies in transgenic crops. Functional genomics and genome editing in Entomology.

**Practical :** Isolation of DNA/RNA; purity determinations, purification of total DNA from animal tissues; base pair estimation; agarose gel electrophoresis; cloning and transformationin bacteria, plasmid isolation, restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques, PAGE, bioinformatics, cell lines maintenance. Molecular characterization of Bt cotton resistant mutant strains of Pink bollworm.

**Ent.-610 Integrated Pest Management** **2+0** **Sem. I**

**Unit I** Principles of sampling and surveillance, database management and computer programming; simulation techniques, system analysis and modeling.

**Unit II** Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.

**Unit III** Genetic engineering and new technologies- their progress and limitations in IPMprogrammes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.

**Unit IV** Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect Pest management under protected cultivation; strategies for pesticide resistance management. Causes and basis of insect resistance to plants and management strategies. Some important case studies.

**Ent.-611 Melittology and its Applications** **2+1** **Sem. II**

**Unit I** Apis genus, etymology, fossil and extant species. Apisdorsata and Apis florea– etymology, subgenus,subspecies. Apis mellifera and Apis cerana - evolution, lineages, subspecies, geographic distribution, dispersal. Taxonomic keys for identification of Apocrita down in the hierarchy upto Apidae and

its subfamilies and tribes of Apinae. Evolutionary modifications and adaptations in honey bee structure and life and advantages. Honey bee pheromones, their structure/ composition, source organs and functions. Visual acuity, flicker fusion frequency, colour vision and memory, response to shapes and patterns. Gut flora diversity and adaptive life advantages. Food and eating/ feeding by honey bees, principles of honey bee nutrition, non- utilization and toxicity of food ingredients.

**Unit II** Nutritional, biochemical and molecular regulation of caste determination. Honey bee genetics, subfamilies, common mutants and inheritance, mosaics and gynandromorphs. Arrhenotoky/ Thelytoky in Cape bees, cytological and molecular regulatory mechanism, evolutionary adaptations and advantages, bottlenecks in beekeeping. Molecular genetics and QTLs for important economic traits andfield applications. Spermatogenesis, sperm storage and maturation and sexual maturity of drones. Haploid drones, diploid drones and drones produced by laying worker bees, their semen volume, sperm count, sperm viability, and their fate and application. Ovarian development and oogenesis in unmated and mated queen bees, and in worker and laying worker bees. Bee breeding protocols.

**Unit III** Bee colony temperature and RH thresholds, thermo-regulation systems. Foragingbehaviour, floral fidelity and constancy and their adaptive advantages. Communication and navigation mechanisms for search of food source. Colour, gustatory and olfactory cues in bee flora. Nectars toxic to bees and honeys toxic to man. Apiculture value of beeflora, state-wise floral calendars, inter-state migratory routes. Impact of agronomic and climatic factors on apiculture value of bee flora. Palynology for apiculture, pollen size, shape, aperture characteristics, ornamentation; nutritional value for bees. Models and protocols for crop-specific pollination requirement assessment. Plannedbee pollination package, hiring-renting systems for honey bee colonies for crops' pollination. Procedures in quantitative estimation of bees contribution in state and national agricultural economy.

**Unit IV** Emerging pests and diseases menaces in India and world. Field diagnosis, and biochemical and molecular characterization and techniques in disease and parasite diagnoses. Advances in the management of bee diseases and enemies. Breeding for pest and disease resistance. Good Apicultural Practices (GAP). Honey bee toxicology, toxicity categories, LD50 oral and contact (dermal/ direct & ICT), hazard quotient, semi-field and field studies, larval toxicity, sub-lethal effects, International protocols. Principles and application of PER.

**Unit V** Honey types. Enzymatic conversion of nectar into honey. Recent technologies in the production/ collection of various hive products. Melissopalynology, pollen frequency. Honey processing – exhaustive unit operations and application criteria. Honey crystallization – prevention and curing, making cream honey. Pollen and bee-bread. Beeswax sources, wax recovery and yield. Solar wax melting and filtration, comb foundation making. Propolis types, sources, purification and extraction. Technologies for pollen drying and royal jelly lyophilisation. National and International Standards organizations; national, international and foreign standards for various hive products for their quality and authenticity, and of apicultural processes and tools &machinery. Apitherapy – uses and application of bee venom including for botox; ulleotherapy, aerosol therapy, massage, larnil. Hive products export statistics, importing countries and procedures. Honey bee package technology. Organic apiculture.

**Unit VI** Xylocopiculture, Bombiculture, Meliponiculture, Megachiliculture and scope of other non-Apis pollinators, theirspecific relative utility, conservation and mass rearing and multiplication practices. Crop pollination under protected cultivation. Impact of modern agricultural and industrial practices on pollinators diversity and intensity.

**Practical :** Study of taxonomic characters of Apocrita, Aculeata, Apoidea and its families, and of Apinae, Xylocopinae, Apini, Xylocopini and Meliponini. Study of sulci and sutures, eyes structures, antennal sensillae, and spiracles. Inner and outer surfaces of three pairs of legs of worker, queen and drone bees. Study of head, thoracic and abdominal glands. Dissection and examination of digestive, excretory, reproductive and nervous systems. In-vivo observations on functioning of pheromones. Bees behaviour undervarious colours of light; bees response to various shapes and patterns. Microscopic and molecular study of gut flora. Study of efficacy and efficiency of diets, examining brood mortality, worker bee longevity, hypopharyngeal gland development, etc. Study of drone sperms in seminal vesicle, out semen and spermatheca - size, count and viability. Selection of colonies for economic traits for bee breeding. Techniques in preparing mating nuclei and queen cell transplantation. Queen cell transplantation

and queen introduction in queen-right colonies. Two queen colony system. Process of migration of honey bee colonies. Augmenting drone rearing, and collection and storage of semen. Hands-on practice on instrumental insemination of queen bees and performance evaluation. Assessing inbreeding depression. Study of symptoms of laying worker colonies, ovaries of laying worker bees, examining drones in worker cells and their semen characteristics. Studying various bee dances in bee colony anddrawing inferences. Assessing honey production potential of crops. Study of state- wise floral calendars for N-W India. Preparing inter-state migratory routes for N-W India. Preparing permanent pollen slides of important bee flora and studying pollen characteristics. Assessing pollination requirement of crops with different floral phenologies. Monetary estimation of bees contribution in agricultural economy. Biochemical and molecular characterization and diagnosis of bee diseases. Good Apicultural Practices (GAP). Assessing LD50 oral and contact (dermal/ direct & ICT) and hazard quotient for pesticides recommended on bee flora during blooming. Laying-out semi-field and field level toxicity assessment. Assessing larval toxicity of insecticide. Assessing sub-lethal effects on bees using PER. Preparing and packaging comb honey. Application of various models of venom extractors. Working out pollen frequency inhoney. Acquaintance with honey processing.Making cream honey. Solar wax meltingand filtration. Automatic comb foundation making process. Propolis purificationand preparing extracts. Mechanical drying of bee collected pollen. Lyophilisationof royal jelly. Learning national, international and foreign standards for various hiveproducts and apicultural processes and tools and machinery. Acquaintance with aerosol apitherapy and preparing larnil. Preparing honey bee packages. Exposure to Xylocopiculture, Bombiculture, Meliponiculture and Megachiliculture.Conservation practices for othernon-Apis bees.

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|---|---|
| **Ent.-691 Seminar I** | **1+0** |
| **Ent.-692 Seminar II** | **1+0** |
| **Ent.-699 Ph.D. Research** | **0+75** |

# FOOD TECHNOLOGY (PROCESSING TECHNOLOGY)

## PROGRAMMES

**B.Tech. Food Technology**

**M.Tech. Food Processing Technology**

**Ph.D. Food Processing Technology**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of specialization | Cereal Technology, Fruit and Vegetable Technology, Dairy Technology, Egg and Meat Technology |
| Core Courses | FPT-501, FPT-502, FPT-503 |
| Minor fields | Microbiology, Biochemistry, Processing and Food Engineering, Food and Nutrition or any other (other than supporting) as approved by Dean Postgraduate Studies |
| Supporting Courses | Stat.-502, and courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problems |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency courses for Students with graduation in discipline other than Food Technology | FT 301, FT 302, FT 303 and other courses as recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Cereal Technology and Fruit & Vegetable Technology |
| Core Courses | FPT-601, FPT-603 |
| Minor fields | Microbiology, Biochemistry, Processing and Food Engineering, Food and Nutrition or any other (other than supporting) as approved by Dean Postgraduate Studies |
| Supporting courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problems. |
| Deficiency courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Course

**FT 51 Elementary Food Technology** **1+1** **Sem. II**

**(For students of two year diploma in Agriculture)**

Causes of food spoilage. Principles of processing and preservation of food by heat, low temperature, chemicals and fermentation. Preservation through ultraviolet and ionizing radiations. Post harvesthandling and technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry. Food safety, adulteration and food laws. Status of food industry in India.

**Practical:** Quality assessment of cereals, fruits, vegetables, egg, meat and poultry. Value added products from cereals, fruits, vegetables, milk, egg and meat. Visit to local food processing units.

## Undergraduate Courses

**FT 101 Food Science and Processing** **1+1** **Sem. I**

**(For students of B.Tech. Biotechnology)**

Definition: Food and nutrition; Food production and consumption trends in India; Major deficiencies of calories, proteins, vitamins and micronutrients; food groups and concept of balanced diet; RDA. Causes of food spoilage; principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation; preservation through ultraviolet and ionizing radiations. Post-harvest handling and technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; food safety, adulteration and food laws; status of food industry in India.

**Practical:** Quality assessment of cereals, fruits, vegetables, egg, meat and poultry. Value added products from cereals, fruits, vegetables, milk, egg and meat. Visit to local processing units.

**FT 102 Food Chemistry of Macroconstituents** **2+1** **Sem. II**

Nature, scope and development of food chemistry. Moisture in foods. Role and type of water in foods, functional properties of water, water activity and sorption isotherm. Molecular mobility and food stability. Dispersed systems of foods, physicochemical aspects of food dispersion system (sol, gel, foam, emulsions). Rheology of diphase systems. Carbohydrates, changes of carbohydrates on cooking, modification of carbohydrates, dietary fibres and carbohydrate digestibility, enzymatic and chemical reactions of carbohydrates. Proteins in foods. Processing induced physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein. Lipids in foods, role and use of lipids/fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto- oxidation, thermal decomposition. Chemistry of frying technology of fat and oil. Oil processing, refining, hydrogenation, inter esterification. Safe use of oils and fats in food formulation. Enzymatic and chemical reactions of fats. Rancidity and its types, detection techniques, chemical aspects of lipids. Antioxidants.

**Practical:** Determination of moisture content of foods using different methods. Studies of sorption isotherms of different foods. Swelling and solubility characteristics of starches. Rheological properties of food systems. Determination of crude proteins by micro-Kjeldhal method. Determination of essential amino acids - lysine, tryptophan, methionine etc. Isolation of egg and milk protein. Preparation of protein isolates and concentrates. Determination of acid value, saponification value and iodine number of fat/oil. Assay of amylases, papain and lipases.

**FT 201 Fundamentals of Food Processing** **1+1** **Sem. I**

**[For students of B.Tech. Food Technology and B.Sc. (Hons.) Horticulture]**

Scope and importance of food processing.Sources, types and perishability of foods. Causes and types of food spoilage. Food preservation - principles, methods, benefits, effects on food quality and equipments. Methods of preservation: salt and sugar, heat treatment, low temperature, drying,dehydration, concentration, fermentation, irradiation, chemicals - acidulants, antioxidants, mold inhibitors and antibodies. Principles,

methods and equipments for thermal processes - blanching, canning, pasteurization and sterilization. Principles and equipments for non-thermal processes - pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic heating, infrared heating, high pressure processing and microwave processing. Quality tests and shelf-life of preserved foods.

**Practical:** Demonstration of various perishable food items and assessment of degree of spoilage. Blanching of selected food items. Preservation of food by heat treatment- pasteurization and sterilization. Preservation of food using high concentration of sugar (jam), salt (pickle), acidulants (pickling by vinegar or acetic acid) and chemical preservatives. Preservation of bread and cake using mold inhibitors. Drying of foods - fruit slices (pineapple and apple) and green leafy vegetables in cabinet dryer, mango/other pulp by foam-mat dryer, semisolid foods by roller dryers and vegetables slices by freeze dryer. Preserving foods under cold and freezing process. Processing of foods using fermentation technique - sauerkraut. Effect of high pressure on microbes. Effect of pulse electric field on food.

**FT 202 Processing Technology of Liquid Milk** **1+1** **Sem. I**

Dairy development in India. Production, utilization, composition and properties of milk. Milk- collection, preservation, processing, packaging and storage. Standardized, skim, sterilized, reconstituted/rehydrated, recombined, flavoured milk. Cream - definition, classification, manufacture and processing. Fermented milk - types, processing, manufacture, storage, packaging, biochemical changes, factors affecting these changes and their effects on the quality. Milk adulteration and detection. Quality defects in milk - causes and prevention. Processing equipments - Bulk milk coolers, chilling units, reception equipment, tanks/ silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines and CIP units. Hygienic design concepts, corrosion process and control.

**Practical:** Platform tests of raw milk - clot on boiling and alcohol tests. Determination of physico-chemical and microbiological properties of milk. Detection of adulterants in milk. Identification and demonstration of liquid milk processing equipment, pipes and fittings. Standardization, separation, pasteurization, homogenization and packaging of liquid milk. Preparation of fermented milk. Visit to chilling centre and dairy plant.

**FT 203 Food Additives and Preservatives** **1+1** **Sem. I**

Intentional and unintentional food additives, their toxicology and safety evaluation. Naturally occurring food additives. Food colours and dyes. Regulatory aspects of dyes, food colours (natural and artificial). Pigments and utilization as food colour. Processing of natural and artificial food colorants. Food preservatives and their chemical action. Role and mode of action of salts, chelating agents, stabilizers, thickeners, humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, acidity regulators, emulsifiers, nutritional and non-nutritional sweeteners, Production of enzymes, leavening agents and fat substitutes. Flavor and taste enhancers in food processing.

**Practical:** Evaluation of GRAS aspect of food additives. Estimation of chemical preservatives by TLC (organic and inorganic). Identification of food colour by TLC (organic and inorganic). Quantitative estimation of added dyes. Isolation and identification of naturally occurring food pigments by paper and TLC. Role and mode of action of chelating agent in fruit juice, stabilizer and thickener in frozen dairy products, clarifying agent in fruit juices, antioxidant in frozen fish and leavening agent in baked food product. Preservation of coconut shreds using humectants.

**FT 204 Food Chemistry of Microconstituents** **2+1** **Sem. I**

Chemistry of food flavour. Philosophy and definitions of flavour, flavourmatics/ flavouring compounds. Sensory assessment of flavour. Technology for flavour retention. Pigments in animal and plants kingdom - Heme pigments, chlorophyll, carotenoids, phenolics, flavonoids and betalains. Effect of processing on pigment behaviour. Technology for retention of natural colours of food stuffs. Colour losses during thermal processing. Vitamins and minerals - requirements, allowances, enrichment, restorations, fortifications, losses, optimization and retention. Chemistry of anti-nutritional factors. Enzymes in food industry- carbohydrases, proteases and lipases. Modification of food using enzymes. Role of endogenous enzymes in food quality. Use of enzymes as processing aid and ingredients.

**Practical:** Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations). Estimation of calcium, phosphorus, iron and magnesium. Estimation of tannins and phytic acid from food. Determination of vitamin A (total carotenoids), ascorbic acid, thiamine and riboflavin. Determination of food colours. Assessment of hydrocolloids as food additives. Assessment of various pectinases from fruits and vegetables.

**FT 205 Processing Technology of Meat and Poultry Products 2+1 Sem. II**

Sources and importance of meat and poultry. Status of meat and poultry industry in India. Pre- slaughter and slaughtering operations for animals and poultry. Evaluation of animal carcasses. Factors affecting post-mortem changes, properties and shelf life of meat. Mechanical deboning, grading and aging. Eating and cooking quality of meat. Preservation of meat by chilling, freezing, pickling, curing, cooking, smoking, dehydration, radiation, chemical and biological preservatives. Meat tenderization. Meat emulsions. Meat cutting and handling. Preparation, preservation and equipment for manufacture of smoked meat, dehydrated meat, meat sausages and their quality evaluation. Abattoir design and layout. Eggs - structure, composition, quality characteristics, processing and preservation. Processing and preservation of meat and poultry products. Meat plant sanitation and safety. By-products of meat, poultry and eggs and their utilization. Safety standards in meat industry. HACCP/ ISO/ MFPO/ FSSAI/ Kosher/ Halal.

**Practical:** Pre-slaughter operations of meat animals and poultry birds. Slaughtering and dressing of meat animals. Study of post-mortem changes. Meat cutting and handling. Preservation of meat by freezing, curing, pickling and dehydration. Evaluation of quality and grading of eggs. Preservation of shell eggs. Preparation of value added meat, poultry and egg products. Visit to abattoir.

**FT 206 Technology of Bakery, Confectionery and Snack Foods 2+1 Sem. II**

Bakery products - types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing. Confectionery and chocolate products - types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing. Product quality characteristics, defects, causes and corrective measures. Snack foods - types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing. Snack food seasonings. Breakfast cereals, macaroni products and malts - specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing.

**Practical:** Identification and composition of various ingredients for snacks, bakery and confectionery products. Flours, their classifications and characterization. Preparation, packaging and quality evaluation of selected snack items, bakery items, confectionery items, selected chocolates, traditional Indian confection. Visit to bakery, confectionary and snack units (industry).

**FT 207 Processing Technology of Legumes and Oilseeds 2+1 Sem. II**

Present status and future prospects of legumes and oilseeds. Morphology, classification, types, chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds. Methods of removal of anti-nutritional compounds. Pulse milling - home, cottage and modern milling methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity. Problems in dhal milling industry. Nutritional changes during soaking and sprouting of pulses. Cooking quality of dhal, methods and factors affecting cooking of dhal. Quick cooking and instant dhal. Soybean milk processing and value addition. Fermented products of legumes. Oil seed milling - ghanis, hydraulic presses, expellers, solvent extraction methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity. Problems in oil milling industry. Desolventization, refining, degumming, neutralization, bleaching, filtration, deodorization and hydrogenation - their principles and process controls. New technologies in oilseed processing. Utilization of oil seed meals. High protein products like protein concentrates and isolates. By- products of pulse and oil milling and their value addition.

**Practical:** Determination of physical properties of legumes and oil seeds. Determination of proximate composition and nutritional quality of selected pulses and oilseeds. Study of mini dhal mill and mini oil mill. Preconditioning of pulses and oilseeds before milling. Removal of anti-nutritional compounds from selected pulses and oilseeds. Laboratory milling of selected pulses, oilseeds and its quality evaluation. Laboratory refining of selected oils. Laboratory hydrogenation of selected oils. Study of cooking quality of

dhal. Processing of composite legume mix and preparation of value added products. Visit to commercial dhal and oil mills.

**FT 208 Processing Technology of Spices and Plantation Crops 1+1 Sem. II**

Production and processing scenario and scope of spices and plantation crops. Major (Ginger, chilli, turmeric, onion, garlic, pepper and cardamom) and minor spices, (Herbs, leaves and spartan seasonings, allspice, annie seed, sweet basil, caraway seed, cassia, cinnamon. clove, coriander, cumin, dill seed, fennel seed, nutmeg, mace, mint marjoram, rosemary, saffron, sage, Savory, thyme, ajwain, Asafoetida and curry leaves) their post harvest technologies, composition and processed products. Post harvest technology and processing for tea, coffee, cocoa, vanilla and annatto. Post harvest technology and processing of areca nut, cashew nut and oil palm. Flavours of major and minor spices. Extraction techniques for spice oil and oleoresins. Standards and specifications of spices. Functional packaging of spices and spice products. By-products of plantation crops and spices.

**Practical:** Identification and characterization of flavouring compounds of spices. Valuable oil determination. Extraction of oil from clove, pepper, cardamom and chilli. Extraction of oleoresins from turmeric, ginger, pepper and cloves. Peperine estimation in pepper oleoresin. Steam distillation of spices. Determination of curcumin content in turmeric. Chemical analysis of spices-moisture, valuable oil, specific gravity, refractive index and acid value. Packaging study of spices. Preparation of curry powder. Visit to spice industry.

**FT 209 Grading Standardization and Quality Management in Agri Food Products 2+1 Sem. I**

**[For students of B.Sc. (Hons.) Agribusiness Management]**

Grading and standardization meaning-Significance of grading and standardization. Types of grading-fixed grading/mandatory grading, permissive/variable grading, centralized grading/decentralized grading and Grading at producers' level. Criteria for grade standards and advantages of grading. Role of grading in Agril. Products The agricultural produce (Grading and Marketing) Act, 1937. Quality control of Agril. Products AGMARK standards, the role of DMI in grading of Agril. Produce, Inspection and quality control, labeling in Agril. Products. Grading of food grains (cereals, pulses and oilseeds) - special characteristics, general characteristics, safety parameters, determination of quality. Impurities refractions of food grains foreign matter- organic and inorganic, admixtures, damaged and discolored grains, slightly damaged grains and immature and shriveled grains, Chalky, weevils, broken, fragments, other food grains, non-food grains, Smutty grains, whole grains. Inherent and acquired characteristics of food grains. AGMARK standards of oilseeds and oils. Grading of commercial crops- special and general characteristics. Classification and grading of fruits and vegetables. Quality control of manufactured products - Indian standards Institution (ISI) - aims andobjectives of ISI, granting licenses for ISI, Bureau of Indian Standards (BIS). Management systems certification. Spot exchange grade requirements, Mark to identify vegetarian/non vegetarian food, Eco mark. Mark of FPO and ISO standards. Quality control in food- food hygiene, food adulteration and food poisoning. Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP). EUREPGAP Quality management in food. FSS Act 2006, Hazard Analysis and Critical Control Point (HACCP), Codex Alimentarius commission (CODEX), Fair Average Quality (FAQ).

**Practical:** Introduction to laboratory equipment, Sampling of food products for quality evaluation, Implementation of HACCP in quality management, Grading and quality assessment of food grains, Grading and quality assessment of fruits and vegetables, Determination of food hygiene and adulteration, Visits to food markets and food processing units.

**FT 301 Processing Technology of Fruits and Vegetables 2+1 Sem. I**

Production and processing scenario of fruits and vegetables in India and world. Scope of fruit and vegetable processing industry in India. Overview of principles and preservation methods of fruits and vegetables. Supply chain of fresh fruits and vegetables. Primary processing and pack house handling of fruits and vegetables. Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables. Minimal processing of fruits and vegetables. Blanching operations and equipment. Canning-definition, processing steps, equipment, cans and containers, quality assurance and defects in canned products. FSSAI specifications, preparation, preservation and equipments used for juices, squashes, syrups, sherbets, nectars, cordials, crystallized fruits preserves, jam, jelly, marmalades, candies, chutney,

pickles, sauce, puree, paste, ketchup, toffee, fruit cheese, leather, dehydrated products, wafers, papads and soup powders. Production of pectin and vinegar. Commercial processing technology of selected fruits and vegetables for production of various value added processed products.

**Practical:** Primary processing of seasonal fruits and vegetables. Canning of Mango/Guava/ Papaya/ sarson ka saag/peas. Preparation of jam, jelly and marmalade from selected fruits. Preparation of RTS, beverages, squash and syrup, Preparation of raisins, dried fig, dried banana, anardana. Dehydration of ginger, onion, garlic, leafy and other vegetables. Preparation of banana and potato wafers. Preparation of papain. Preparation of pickles. Visit to fruits and vegetables pack house, canning plant and vegetable dehydration plant.

**FT 302 Processing Technology of Cereals** **2+1** **Sem. I**

Present status and future prospects of cereals and millets. Morphology, physico-chemical properties and nutritive value of cereals, major and minor millets. Paddy processing and rice milling- conventional and modern methods. Quality characteristics influencing final milled product. Parboiling. Rice bran stabilization and its methods. Wheat milling- break, purification and reduction system. Extraction rate and its effect on flour composition. Quality characteristics of flour and its suitability for baking. Corn/Maize milling - dry and wet, starch separation, milling fractions and modified starches. Barley malting and milling. Oat - processing and milling. Sorghum - milling, malting and pearling. Millets processing for food uses. Secondary, tertiary and byproduct processing of cereals and millets. Processing of cereals and millets for infant and baby foods. Breakfast cereal foods- flaked, puffed, expanded, extruded and shredded.

**Practical:** Morphological, physical and chemical properties of cereals. Milling and cooking quality of rice. Parboiling of paddy. Conditioning and milling of wheat into different products and their evaluation. Production of sorghum flakes, popcorns, flaked rice, puffed rice and noodles. Preparation of barley malt. Determination of gelatinization temperature by amylograph. Processing of value added products from millets. Visit to cereal processing unit.

**FT 303 Processing Technology of Dairy Products** **2+1** **Sem. I**

Classification of dairy products. Butter - definition, composition, processing, equipment, overrun, quality testing, defects - causes and their prevention, packaging and storage. Butter oil and ghee - definition, composition, processing, equipment and quality tests. Paneer and cheese - definitions, composition, types, processing, equipment, quality defects- causes and prevention, packaging and storage. Ice cream and frozen desserts - definition, composition, types, processing, equipment, quality testing, defects - causes and prevention, packaging and storage. Condensed and dried milk definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk, manufacture of skim milk powder (SMP) and whole milk powder (WMP) using roller and spray drying, instantization, recent developments in drying, quality testing, defects- causes and prevention, packaging and storage. Traditional Indian dairy products - definitions, composition, processing, packaging, storage, equipment and quality testing. Byproducts of dairy industry and their utilization (lassi, whey and ghee residue).

**Practical:** Preparation of butter / table butter, *ghee*, *paneer*, selected type of cheese, ice-cream, selected frozen desserts, condensed milk, milk powder, selected Indian dairy products. Determination of quality parameters of dairy products. Visit to dairy plant.

**FT 304 Sensory Evaluation of Food Products** **2+1** **Sem. I**

Introduction, definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects. Factors affecting food acceptance. Terminology related to sensory evaluation. Principles of good practice. Sensory testing environment, test protocol considerations and their basic principles. Senses and sensory perception. Physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses - visual, auditory, tactile and other responses. Discrimination tests. Types of tests – difference tests (paired comparison, duo-trio, triangle), ranking, scoring, Hedonic scale and descriptive tests. Panel selection - screening and training of judges. Requirements of sensory evaluation. Sampling procedures. Factors influencing sensory measurements. Consumer research – effective tests, objectives, methods, types and development of questionnaires. Comparison of laboratory testing and consumer studies along with their limitations.

Interrelationship between sensory properties of food products and various instrumental and physico - chemical tests. Application of sensory testing.Sensory evaluation in food product development and quality control.

**Practical:** Determination of threshold value for basic tastes and odours. Selection of judging panel. Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests- difference test (Paired Comparison (PC), Duo-trio, triangle). Descriptive analysis methodology. Sensory evaluation of various food products using different scales, score cards and tests. Texture profile methodology. Estimation of colour. Relationship between objectiveand subjective methods. Designing a sensory laboratory.

**FT 305 instrumental techniques in Food Analysis** **1+2** **Sem. I**

Concepts of food analysis. Rules and regulations of food analysis. Principles and methodology involved in food analysis, rheological, textural profile, proximate and mineral analysis of foods. Adulteration analysis. Principles and methodology in analytical techniques- Ion selective electrodes, spectroscopy, ultraviolet, visible, florescence, infrared spectroscopy, atomic absorption and emission mass spectroscopy, nuclear magnetic resonance (NMR) and electron spin resonance. Chromatography- Adsorption, column, partition, gel-filtration, affinity, ion - exchange, size-exclusion, gas-liquid chromatography (GLC), high performance liquid chromatography (HPLC). Separation techniques - dialysis, electrophoresis, sedimentation, ultra-filtration, ultracentrifugation, iso-electric focusing, isotopic techniques, manometric techniques. Immuno assay techniques in food analysis by IR and NIR. Principles, measurement, instrumentation for food analysis including statistical evaluation of analytical data. Rapid microbiological methods. Principles of food sensing techniques and sensors for flavour and freshness. Electronic nose and tongue.

**Practical:** Sampling plan, sample collection and preparation for analyses. Sensory evaluation of products. Quality evaluation of raw material, fruits, vegetables, cereals, dairy products, meat and poultry products. Quality evaluation of market food products for colour and taste. Analysis of heavy metals using atomic absorption spectrophotometer. Estimation of phytic acid using spectrophotometer. Separation of amino acids by paper chromatography. Identification of sugars in fruit juice using TLC. Gel electrophoresis - quantitative determination of sugars and fatty acid profile. Quantitative make-up of water and fat soluble vitamins using HPLC. Separation of sugars by paper chromatography. Analysis of wheat flour. Analysis of foods for pesticide and drug residues. Study of colourimetry and spectrophotometry. Spectrophotometric method for total chlorophyll (A & B).

**FT 306 Food Plant Sanitation** **1+1** **Sem. II**

Good manufacturing practices, standard operating procedures and good laboratory practices. Sanitation and food industry - laws, regulations and guidelines. Relationship of microorganisms to sanitation. Allergens and their control. Food contamination and protection. Personal hygiene and sanitary food handling. Role of HACCP in sanitation and quality assurance. Cleaning compounds, sanitizers, sanitizing methods, sanitation equipment, waste product handling, solid waste disposal and liquid waste disposal. Pests' infestation in food and integrated pest management. Sanitary design for construction for food processing unit. Low-moisture food manufacturing and storage sanitation. Sanitation in dairy, meat, poultry, seafood, fruit and vegetables, beverage, brewery and wine processing plants. Potential risks of bioterrorism due to food and other items.

**Practical:** Determination of BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand) of industrial effluents. Determination of hardness of water. Good Manufacturing Practices (GMPs) and personal hygiene. Primary, secondary, tertiary and quaternary aerobic and anaerobic sludge treatment. Lab demonstration on state of water. CIP plant. Isolation and identification of actinomycetes. Enrichment and isolation of cellulose degrading bacteria. Biodegradation of phenol compounds. Bacteriological examination of water. Coliform MPN test. Sampling of airborne microorganisms. Sampling from surfaces, equipment and plant. Aerosol sampling and measurement guidelines.

**FT 307 Processing Technology of Fish and Marine Products** **1+1** **Sem. II**

Fisheries resources-global and Indian scenario. Types of fish and other marine products. Classification, composition and characteristics of fresh water and marine fish. Spoilage of fish - microbiological, physiological and biochemical. Relationship between chilling and storage life, fish freezing, changes in

quality during chilled and frozen storage. Canning of fish pre and post process cannery operations, storage of canned fish. Fish products - muscle proteins, fish protein concentrates (FPC), fish protein extracts (FPE) and fish protein hydrolysates (FPH), surimi process (traditional and modern production lines, quality and comparison with other fish mince products). Preparation of protocolsfor indigenous products. Fish sauce and paste. Novel methods - low dose irradiation, high pressure treatment, MAP, Vacuum & gas packaging, hurdle barrier concept. Value added fish products and their packaging. Sea food quality assurance - HACCP, EU hygienic regulations and ISO 9000 standards. New kinds of quality and safety problems emerging in sea food processing and preservation.

**Practical:** Study of anatomy and dressing of fish, prawn and other marine products. Identification of different types of fish, prawn and other marine products - selection and grading. Quality evaluation of fish. Preservation of fish by drying, canning, pickling, chilling and freezing. Preparation of sun dried, salt cured, sauce, protein concentrate, meal, oils and various other products from fish. Utilization of fish byproducts. Preparation of marine algal products. Determination of iodine value. Protein estimation by Folin-Lowrey's method. Visit to fish and prawn processing industry.

**FT 308 Processing Technology of Beverages** **2+1** **Sem. II**

History, importance and status of beverages industry. Packaged drinking water, juice based beverages, synthetic beverages, still, carbonated, low-calorie and dry beverages, isotonic and sports drinks, dairy based beverages, alcoholic beverages, fruit beverages, speciality beverages, tea, coffee, cocoa, spices, plant extracts, etc. FSSAI (Food Safety and Standards Authority of India) specifications for beverages. Ingredients, manufacturing, packaging processes and equipment for different beverages. Water treatment and quality of process water. Sweeteners, colourants, acidulants, clouding, clarifying and flavouring agents for beverages. Carbon dioxide and carbonation. Quality tests and control in beverages. Miscellaneous beverages - sugar cane juice, coconut beverages and flavouredsyrups.

**Practical:** Quality analysis of water. Determination of density and viscosity of caramel. Determination of colours in soft drinks by wool technique. Preparation of iced and flavoured tea. Preparation of carbonated and non-carbonated beverages. Determination of caffeine in beverages. Determination of brix value, gas content, pH and acidity of beverages. Quality analysis of tea and coffee. Preparation of miscellaneous beverages. Visit to carbonation unit and mineral water plant.

**FT 309 Food Quality, Safety Standards and Certification** **2+0** **Sem. II**

Food quality-definition and its role in food industry. Qualityattributes, classification. Physical properties of food. Defects - classification and measurement. Colour and gloss - definition, different colours, colour measurement by spectrophotometer, Munsell colour system and Lovibond tintometer. Role of viscosity and consistency in food quality. Flavour - definition and its role in food quality. Taste and Odor - definition, classification and its role in food quality. Factors influencing sensory measurements. Correlation of sensory and instrumental analysis. Descriptive sensory analysis by contour and other procedures. Consumer measurement - factors influencing acceptance and preference, objectives of consumer preference and information obtained from consumer study. Development of the questionnaire, types of questionnaires and serving procedures. Laboratory panels versus consumer panels. Limitations of consumer survey. Physical, chemical and microbial quality of raw material and processed products. Colour, taste, texture, flavor and appearance. Factors influencing the food quality - soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products. Recording and reporting of quality. Quality - inspection and control. Quality management and quality assurance- total quality management (TQM), good manufacturing practices (GMP), good agricultural practices (GAP), and good laboratory practices (GLP). Quality management systems - quality services and solutions (QSS). Quality circles and statistical quality control (SQC). ISO system. HACCP - principles, implementation, plan documentation and record keeping. Auditing - surveillance, audit, mock audit, third party quality certifying audit, auditors and lead auditors. Certification - procedures, certifyingbodies, accrediting bodies and international bodies.

**FT 310 Food Packaging Technology and Equipment** **2+1** **Sem. II**

Packaging situations in India and world. Packaging requirements, functions and material classification. Paper- manufacture, types and advantages of corrugated and paper board boxes, etc. Glass- manufacture,

advantages and disadvantages. Metal (Aluminum / tin/ SS) - manufacture, advantages, disadvantages. Plastic– classification, properties and uses. Lamination. Moulding-injection, blow and extrusion. Coating on paper and films. Aseptic packaging – need, advantages, process, comparison of conventional and aseptic packaging, Permeability in relation to packaging requirement of foods. Transport properties of barriers. Simulations of product. Package environment interaction. Packaging of specific foods. Mechanical and functional tests on package.

**Practical:** Classification of various packages based on material and rigidity. Measurement of thickness, basic weight, grammage, water absorption, bursting strength, tear resistance, puncture resistance, tensile strength and grease resistance of paper and paper boards. Determination of gas and water transmission rate of package films. Determination of laquer integrity, drop test and box compression test. Identification of plastic films. Determination of seal integrity and ink adhesion. Packaging practices for fruits and vegetables. Shelf life calculations for food products. Head space analysis of packaged food. Study of vacuum packaging, bottle filling and form-fill-seal machines.

**FT 313 Principles of Food Science and Nutrition** **2+0** **Sem. I**

**[For students of B.Sc. (Hons.) Agriculture]**

Concepts of Food Science - definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc. Food composition and chemistry - water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, bioactives and important reactions. Food microbiology bacteria, yeast, moulds, spoilage of fresh and processed foods. Production of fermented foods. Principles and methods of food processing and preservation - use of heat, low temperature, chemicals, radiation, drying, etc. Food and nutrition - Malnutrition (over and under nutrition). Nutritional disorders - energy metabolism (carbohydrate, fat and proteins). Balanced and modified diets. Menu planning. New trends in Food Science and Nutrition.

**FT 314 Food Safety and Standards** **2+1** **Sem. II**

**[For students of B.Sc.(Hons.)Agriculture]**

Food safety - definition and importance. Scope and factors affecting food safety. Hazards and risks. Types of hazards - biological, chemical, physical hazards and management. Control of parameters - temperature, pH etc. Food storage. Product design. Hygiene, sanitation in food service. Establishments - introduction. Sources of contamination and their control, waste disposal, pest and rodent control. Personnel hygiene, food safety measures. Food safety management tools - basic concepts, PRPs, GHPs, GMPs, SSO'Ps, etc. HACCP. ISO series. TQM - concept and need for quality, components of TQM, Kaizen. Risk analysis. Accreditation and auditing. Water analysis, surface sanitation and personal hygiene. Food laws and standards- Indian Food Regulatory Regime and FSSAI. Global scenario and CAC. Other laws and standards related to food. Recent concerns - new and emerging pathogens. Packaging, product labeling and nutritional labeling. Genetically modified foods, transgenics. Organic foods. Newer approaches to food safety. Recent outbreaks related to food safety. Indian and International standards for food products.

**Practical:** Water quality analysis - physico-chemical and microbiological. Preparation of different types of media. Microbiological examination of different food samples. Assessment of surface sanitation by swab/ rinse method. Assessment of personal hygiene. Biochemical tests for identification of bacteria. Scheme for the detection of food borne pathogens. Preparation of plans for Implementation of FSMS - HACCP, ISO: 22000.

**FT 491 Agro-industrial Attachment** **0+4** **Sem. I**

**[For students of B.Sc. (Hons.) Agriculture]**

**Practical:** Fruits and Vegetables Industry, Beverages Industry, Cereal Industry, Milk Industry

**FT 492 Experiential Learning in Food Technologies** **0+20** **Sem. II**

**[For students of B.Sc. (Hons.) Agriculture]**

Experiential Learning in processing of Cereals, Fruits and Vegetables in pilot plants. This shall include development of detailed project report on setting up of enterprise in the selected areas of product

manufacture and evaluation of the module. The experiential learning is intended to build **Practical** skills and entrepreneurship attributes among the students with an aim to deal with work situations and for better employability and self- employment.

**FT/ Mgt 493 Entrepreneurship Development** **2+1** **Sem. I**

Entrepreneurship- importance and growth, characteristics and qualities of entrepreneur, role of entrepreneurship, ethics and social responsibilities, entrepreneurship development. Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business/entrepreneurial environment. Concept of entrepreneurship, entrepreneurial and managerial characteristics, managing an enterprise, motivation and entrepreneurship development, importance of planning, monitoring, evaluation and follow up, managing competition, entrepreneurship development programs, SWOT analysis, generation, incubation and commercialization of ideas and innovations. Women entrepreneurship- role, importance and problems. Corporate entrepreneurship. Role, mobility of entrepreneur. Entrepreneurial motivation. Planning and evaluation of projects. Growth of firm, project identification and selection, factors inducing growth. Project feasibility study. Post planning of project, project planning and control. New venture management. Creativity. Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs. Export and import policies relevant to food processing sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of food industry inputs. Characteristics of Indian food processing industries and export. Social responsibility of business.

**Practical:** Visit to public enterprise. Visit to private enterprise. Visit to agro-processing/food business centres. SWOT analysis of public and private enterprises. Project proposals as entrepreneur - individual and group. Presentation of project proposals in the class.

**FT 494 Student READY-Experiential Learning Programme - I** **0+7** **Sem. I**

**Practical:** Student READY - Experiential Learning in processing of fruits and vegetables in pilot plants. This shall include development of detailed project report on setting up of enterprise in the selected areas of product manufacture and evaluation of the module. The experiential learning is intended to build **Practical** skills and entrepreneurship attributes among the students with an aim to deal with work situations and for better employability and self- employment.

**FT 495 Student READY- Experiential Learning Programme - II** **0+7** **Sem. I**

**Practical:** Student READY - Experiential learning in processing of grains in value added food products in pilot plants. This shall include development of detailed project report on setting up of enterprise in the selected areas of product manufacture and evaluation of the module. The experiential learning is intended to build **Practical** skills and entrepreneurship attributes among the students with an aim to deal with work situations and for better employability and self-employment.

**FT 496 Student READY - Research Project** **0+3** **Sem. I**

**FT 497 Student READY - Seminar** **0+1** **Sem. I**

**Practical:** A power point presentation on any topic chosen from the subjects studied from vocational package to be prepared and delivered to the group of staff and students of department. Organization of topic. Presentation of data. Oral presentation. Delivery, language, explanation of figures. Ability to grasp and understand the subject and depth of understanding the topic.

**FT 498 Student READY- Industrial cum Educational Tour** **0+2** **Sem. I**

**Practical:** Student READY - Educational tour of two-three industries within and outside the state of the university and submission of report on industrial tour carrying a weightage of 0+2 credit hours.

**FT 499 Student READY - In-Plant Training** **0+20** **Sem. II**

**Practical:** Student READY - In-plant training of one semester duration with a credit load of 0+20 credit hours at relevant food processing industry, machinery manufacturer, marketing or other agencies. The In-plant training is intended to expose the students to an environment in which they are expected to be

associated in their future career. The students will be required to have hands-on- experience in one or more commercial establishment.

## Postgraduate Courses

**FPT-501 Emerging Technologies in Food Processing** **2+1 Sem. I Unit I**

**Unit I** Membrane Technology: Pressure activated membrane processes: MF, UF, NF and RO and their industrial application. Supercritical fluid extraction: Concept, property of super critical fluids SCF, extraction methods, application in food processing

**Unit II** Microwave and radio frequency processing: Advantages, mechanism of heat generation, application in food processing. Hurdle technology: Concept and Principle, Preservation techniques as hurdles and their applications

**Unit III** High Pressure processing: Concept, principle, equipment for HPP treatment, mechanism of microbial and enzyme inactivation and its application in food processing, effect on food constituents. Ultrasonic processing: Properties of ultrasonic, types of equipment, mechanism, and application of ultrasonicas processing technique.

**Unit Iv** Newer techniques in food processing*:* principle and application of High intensity light, pulse electricfield, ohmic heating, IR heating, inductive heating, cold plasma, and pulsed X-rays in food processing and preservation, Cryo-processing of foods, Nanotechnology: Principles and applications in foods.

**Practical** : To evaluate the characteristics of treated water using RO system. To study microwave system and to evaluate the effect of different power on drying characteristics of selected vegetable products. To study microwave blanching of vegetable and determination of blanching efficacy. To study the ultrasonicator and evaluate the effect of ultrasonication on micro-organism in sample. To study the ultrasonicator and to evaluate the effect of ultrasonication on extracted juice yield from fruit pomace. To evaluate the different pre-treatment on oil yield from oil seed cake. To prepare nano emulsion and study of their characteristics. To visit food industries utilizing advance food processing techniques. To study the effect of different drying techniques/ hybrid drying techniques on fruits and vegetables.

**FPT-502 Emerging Technologies in Food Packaging** **2+1 Sem. II**

**Unit I** Active and intelligent packaging: Active Packaging Techniques and intelligent Packaging Techniques, current use of novel Packaging Techniques, consumers and novel Packaging Oxygen, ethyleneand other scavengers: Oxygen scavenging technology, selecting right types of oxygen scavenger, ethylene scavenging technology, carbon dioxide and other scavengers. Antimicrobial food packaging: Antimicrobial agents, constructing antimicrobial packaging systems, factors affecting the effectiveness of antimicrobial packaging.

**Unit II** Non-migratory bioactive polymers (NMBP): Advantages of NMBP, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds and their applications. Time Temperature labels and indicators (TTIs): Defining and classifying TTIs, Requirements for TTIs, development of TTIs, Maximizing the effectiveness of TTIs, Application of TTIs- to monitor shelf-life, and optimization of distribution and stock rotation, leakage indicators, oxygen indicators, micro indicators etc. Freshness indicator in packaging: Compounds indicating thequality of packaged food products, freshness indicators, pathogen indicators, other methods for spoilage detection. Self-heating /rehydrating packages.

**Unit III** Packaging-flavour interaction: Factors affecting flavor absorption, role of food matrix, role of differing packaging materials, flavour modification and sensory quality, Study of packaging materials compatibility with foods. Developments in modified atmosphere packaging (MAP): Permeability properties of polymer packaging, measurement of permeability – water and gases. Selection criteria of packaging films, Novel MAP gas, testing novel MAP applications, applying high oxygen MAP. Recycling packaging materials: Recyclability of packaging plastics, improving the recyclability of plastics packaging, testing safety and quality of recycled materials, uses of recycled plastics in packaging.

**Unit IV** Green plastics for food packaging: Problems of plastic packaging wastes, range of biopolymers, developing novel biodegradable materials. Edible Films and Coatings: Properties, types, sources, applications, advantages, disadvantages, theories of plasticization, challenges and opportunities. PFS

machine, seal and closures. Safety and legislative aspects of packaging: Regulatory considerations, plastic, metal, paper and glass packaging.

**Practical** : Determination of WVTR in different packaging materials. Determination of GTR in different packaging materials. Study of different ethylene scavengers and their analysis. Study of different oxygen scavengers systems and their analysis. Determination of oxidative changes in packaged foods. Comparative evaluation of flexible and rigid packages for fragile foods. Determination of oil and grease resistant test for packaging films. Determination of respiration rate in fresh fruits and vegetables. Determination of shelf life of fresh fruits and vegetables by using edible coating and films. Effect of edible coating and films on respiration behaviour, chemical, physical and sensory characteristics of fresh fruits and vegetables. Visit to food packaging material manufacturing industry.

**FPT-503 Industrial Manufacturing of Food and Beverages 2+1 Sem. I**

**Unit I** Grain products: Industrial manufacturing of grain based products: formulation, processes, machinery and material balance of baked, rolled, shredded, puffed, flaked, roasted products. Extrusion technology: Importance and applications of extrusion in food processing; Pre and post extrusion treatments; Manufacturing process of extruded products; Change of functional properties of food components during extrusion. Breakfast cereals, RTE/RTC foods, instant premixes, functional foods.

**Unit II** Fruit and vegetable products: Industrial manufacturing of fruit and vegetable based products: formulation, processes, machinery and material balance of minimally processed, Retorted products, IMF, high moisture stable foods, IQF; Machines and equipment for batch and continuous processing of fruit and vegetable products.

**Unit III** Chocolates and candies: Coating or enrobing of chocolate (including pan-coating); Maintenance, safety and hygiene of bakery plants. Fats and oils processing: Technology of refined oil, winterized oil, hydrogenated fat, texturized fat, by-products of fat/oil processing industries – oil seed protein isolates; Quality standards of fats and fatty foods; Antioxidants and its mechanism of application.

**Unit IV** Beverages: Production technology of beer and wine Non – alcoholic beverages: Carbonated beverages: carbonation equipment, - ingredients- preparation of syrups-Filling system-packaging-containers and closures. Non-carbonated beverage: Coffee bean preparation-processing- brewing-decaffeination- instant coffee, Tea types- black, green, Fruit juices and beverages,. Flash pasteurization, Aseptic Packaging of beverages Tea/coffee and cocoa beverages, Grain based and malted beverages. Packaged drinking water: types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

**Practical** : Preparation of cereals based fried snack foods. Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking their quality evaluation. Preparation of cereal grain based puffed products. Development of instant food premixes. Preparation of cereal and legume based roasted snack. Preparation of flaked rice product. To study the effect of roasting time and temperature on quality of pop-corn. Determination of shelf-life and packaging requirements of snack food products. Preparation of fruits/ vegetable based ready to serve beverages and quality evaluation. Heat classification of milk powders. Determination of degree of browning-chemical/physical methods. Determination of quality of packaged drinking water. Preparation of wine and beer. Preparation of soy milk. Determination of quality of canned food.

**FPT-506 Spices, Herbs and Condiments 2+0 Sem. I**

**Unit I** Introduction: Status and scope of spice processing industries in India; Spices, Herbs and seasonings: sources, production, selection criteria, classification on the basis of origin, physical characteristic. Major spices: Post-Harvest Technology composition, processed products of following spices (1) Ginger (2) Chilli (3) Turmeric (4) Onion and garlic (5) Pepper (6) Cardamom.

**Unit II** Minor spices, herbs and leafy vegetables: All spice, Annie seed, sweet Basil, Caraway seed, Cassia, Cinnamon, Clove, Coriander, cumin, Dill seed, nutmeg, mint, Rose merry, saffron, sage. Processing technology of Spices: Chemical composition, processing methods, equipment's used; recent developments in processing.

**Unit III** Processing effect on spice quality: Effect of processing on spice quality, contamination of spices with micro-organisms and insects.

**Unit IV** Spice Essential Oils: methods of extraction, isolation, and encapsulation, Spice Oleoresins: method of extraction, isolation, separation equipment Spices quality evaluation: Criteria for assessment of spice quality.

**FPT-507 Meat, Poultry, Fish and Egg Processing** **2+1** **Sem. I**

**Unit I** Meat Industry: Meat and meat products in India-an Industrial profile. Meat production and trade practices. Prospects and problems in production of fresh meat in India, Research and Development activities on meat, fish and poultry products. Gross and microstructure of muscle. Mechanism of muscle contraction and relaxation: Organization of skeletal muscle from gross structure to molecular level. Muscle Communication (sarcolemma, sarcoplasmic reticulum, Innervation). Muscle metabolism. Different types of connective tissues and their relevance to properties of meat. Myofilament proteins and their major functions. Nervous tissue, nerves and the nature of stimuli, membrane potential in nerve and muscle, Events that occur during relaxation and contraction.

**Unit II** Cattle and beef, sheep and mutton, pig and pork and their fabrication: Breeds, Pre-slaughter care, ante and post mortem, slaughter, handling of offal (edible and inedible). Cuts of beef, pork and mutton. Meat inspection and grading: Application and Enforcement of inspection laws, elements of inspection (sanitation, antemortem inspection, post-mortem inspection, condemnation, product inspection, laboratory inspection, labelling). Identification of inspected products, product inspection, types of grades, factors used to establish quality grades, conformation, fleshing and finish.

**Unit III** Properties of fresh meat: Perception of tenderness, Factors effecting tenderness, connective tissue, collagen, sarcomere contractile state, Myofibrillar tenderness, marbling. Methods to improve tenderness (Electrical stimulation, aging, Meat colour, Pigments associated with colour, Chemical state of pigments, methods to improve meat colour. Water holding capacity (Net charge effect and stearic effect) Molecular Techniques in meat products, cultured meat etc. Poultry meat: Kind of poultry, processing of poultry. Special poultry products, Breaded poultry, Smoked turkey, packaged precooked chicken, Freeze dried poultry meat. Egg and egg processing: Egg quality, egg preservation, egg powder production

**Unit IV** Meat analogues and restructured meat products: Textured plant proteins, processes for preparation of meat analogues and restructured meat products. Fish processing and fish products: Chemical/ Nutritional composition of Fish, Fish in human diet: protein, carbohydrates, lipids, vitamins etc. Selection of raw material for processing of streaking and filleting of fish; production of fish paste, fish oils, sauce, fish protein concentrates. Irradiation of fish and fisheries products, packaging of fish products, quality control and quality assurance. Allergens, toxins and infectious diseases from meat, poultry and fish products.

**Practical** : To study the effect of low and high oxygen atmosphere on meat colour. To study the chemistry of myoglobin as it relates to the colour of the molecule. To understand and compare the action of twomeat tenderizing enzymes by applying the technique of electrophoresis. To study the structure of themuscle under compound microscope. Perform the slaughtering of the poultry birds. Identification of different internal organs of poultry birds and their utilization for product preparation. Dressing of Fish. Determination of total volatile acids in fish. Determination of buffering capacity of fish muscle. Rapid estimation of hypoxanthine concentration in chill stored fish. Determination of glycine in fishmuscle. Determination of protein fractions in fresh fish. Cut out test for canned fishery products. Determination of glycogen in fish muscle. Industrial visit to meat industry.

**FPT-508 Nutraceuticals and Specialty Foods** **2+1** **Sem. I**

**Unit I** Introduction: Defining nutraceuticals and functional foods. Nature, type and scope of nutraceutical and functional foods. Nutraceutical and functional food applications and their health benefits. Nutraceutical compounds and their classification based on chemical and biochemical nature, Innovations in Functional Food Industry for Health and Wellness, Development of biomarkers to indicate efficacy of functional ingredients. Nutraceuticals and Functional foods: Nutraceuticals / food components for specific disease such ascancer, heart disease, diabetes, obesity, anti-aging, arthritis, Prebiotics0 and

probiotics; Omega 3 and omega 6 fatty acids, Isoflavones, phenolic compounds, catechins, lycopene, glucosinolates.

**Unit II** Specialty Foods: Design of food for infants, children and old age. Functional Beverage: Selection of ingredients, health benefits and production. Extraction and delivery system: Non-thermal techniques, bioprocessing techniques, dehydration techniques, effect on bioactive ingredients. Delivery system and controlled release of nutraceuticals.

**Unit III** Packaging, Storage, labelling: Packaging requirements, storage and storage kinetics on quality of nutraceuticals, interactions of various environmental factors. Marketing and safety aspects: Marketing and safety and regulatory issues for functional foods and nutraceuticals.

**Unit IV** Nutrigenomics: concept of personalized medicine. Use of nanotechnology in functional food industry. Biological functionality of cruciferous vegetables, tropical, subtropical and temperate fruits, herbs and spices.

**Practical** : Determination of antioxidant activity of given food sample by different techniques viz DPPH, FRAP,ABTS, FRAP. Determination of total phenolic content of given food sample. Estimation of dietary fibres of given food sample. Estimation of lycopene in tomato. Estimation of carotenoids of given food sample. Determination of total flavonoid content of given food sample. Effect of heat processing on ascorbic acid. Determination of vitamins A. Estimation of pectic substances in plant sample. Determination of beta carotene of given food sample. To study the effect of drying on bioactive components of food sample. To study the packaging requirement of functional foods. Determination and quantifications of some nutraceutical and functional food compounds. Estimation of β- glucan. To study the storage kinetics of nutraceutical. Estimation of soluble/insoluble fibres of given food sample.

**FPT-509 Frozen and Concentrated Foods** **1+1** **Sem. II**

**Unit I** Freezing: Glass transitions in frozen foods and biomaterials, Microbiology of frozen foods, Thermo-physical properties of frozen foods, Freezing loads and Freezing time calculation, Innovations in freezing process, freezing methods and equipment. Facilities for the Cold Chain: Cold store design and maintenance, Transportation and storage of of frozen foods, Retail display equipment and management.

**Unit II** Quality and safety of frozen foods: Quality and safety of frozen meat and meat product, poultry and poultry products, eggs and egg products, fish and shellfish, and related products, frozen vegetables and fruits, frozen dairy products, frozen ready meals and confectioners.

**Unit III** Packaging of frozen foods: Selection of packaging materials, Plastic and paper packaging of frozen foods, Shelf-life prediction of frozen foods.

**Unit IV** Concentrated milk: Production and quality of evaporated and condensed milk. Concentrated juice products: Production and quality of fruits and vegetable juice concentrate, puree and paste, tomato juice concentrates, mango pulp etc.

**Practical** : Measure the glass transition temperature of food. Calculate freezing load of food sample. Calculate freezing time of a frozen foods. Effect of cold chain on quality of fruits and vegetables. Effect of cooling on egg quality. Effect of chilling on meat quality. Effect of freezing on meat quality. Production of concentrated milk and check its quality. Production of evaporated milk and check its quality. Effect of clarification n juice quality. Effect of juice concentration on juice. Concentrate Effect of cold and hot break on tomato pulp quality. Production tomato puree and paste and check its quality.

**FPT-510 Aseptic Processing and Packaging** **2+1** **Sem. I**

**Unit I** Introduction: present and future of aseptic processing, Advantages and disadvantages, processing of semi-solid and fluid and particulate foods. Aseptic processing operations: pre-sterilization, loss of sterility, water-to-product and product-to- water separation, cleaning, control, CIP.

**Unit II** Quality Assurance: Effect of aseptic processing on nutrients, microorganisms, in-process and post- process assurance, HACCP, regulatory aspects of processing and packaging, Shelf life modules.

**Unit III** Sanitary design and Equipments requirements: Pumps, Heat exchangers, homogenizers, aseptic process and packaging system for retail and institutional packages.

**Unit IV** Packaging of aseptic processed foods: Packaging materials characteristics, aseptic filling, sterilization of packaging materials, package design, aseptic packaging system, type of pack and equipments: Fill and seal, Form, fill and seal, Erect, fill and seal, Thermoform, fill, sealed, Blow mold, fill, seal; geometry, materials and size of retail and bulk package, seal and closures.

**Practical** : Effect of aseptic processing on microbial quality of juice based beverage. Effect of aseptic processing on vitamins in selected foods. Effect of aseptic processing on minerals in selected foods. Effect of aseptic processing on colour pigments in selected foods. Effect of aseptic processing on browning of milk. Effect of aseptic processing on viscosity of milk. Effect of aseptic processing on proteins in selected foods. Effect of different chemical sterilant on microbial quality of packaging material. To estimate chemical sterilant residue on packaging materials. Estimation of package integrity andleakage. Shelf life models and prediction.

**FPT-511 Traditional Foods** **2+1** **Sem. I**

**Unit I** Present status of traditional food products, Globalization of traditional food products; Plans and policies of the Government and developmental agencies. Overview of heat-desiccated, coagulated, fried, fermented traditional food products Process technology for Indian bread (chapatti), paratha, stuffed paratha, panipoori Process technology for Indian fried foods- poori, samosa, sev, fafda, chorafali, Jalebi. Process technology for fermented traditional food and its improvement- pickle, idli, khaman, nan, dahi, dhokla, Spiced buttermilk etc. Process improvement in production of Indian sweets (Halwasan, kajukatli, carrothalwa, Rabdi, chocolate burfi, Chikki etc). Process improvement in production of puffed cereals and grains by microwave technique.

**Unit II** New products based on fruits, vegetables and cereals. Application of membrane technology; microwave heating, steaming, extrusion for industrial production of traditional food products (Shrikhand, Dhokla, wadi, murukku/chakri, Patra, Khandvi). Utilization and scope of legumes and grains in India for novel food products development like- flour,ready to eat products, flour mixes etc (puranpoli, Idlimix,Wada mix, Gotamix). Process technology for convenience traditional food products (ready to eat and serve -Curried vegetables, pulses and legumes), chutneys, paste. Use of natural and permitted synthetic preservatives and new packaging systems for traditional food products.

**Unit III** Techno-economic aspects for establishing commercial units for traditional products. Introduction to traditional foods of India, composition and nutritive values, microbial and biochemical diversity, quality and food safety challenges Processing& Preservation methods of Sweets & Desserts: Kulfi, Falooda, Kheer, khurchan, khoa/mawa, Rabri,jalebi, imarti, Gulab jamun, Peda, petha, rewdi, gajak, milk cake, balushahi, bal mithai, singoni, Ras-malayi,Gulqand, ghevar, rasgolla, chamcham, son halwa, son papri, several varieties of halwa, laddu, barfi & rasgolla.

**Unit IV** Traditional fermented foods: Idli, dosa, Vada, khamman dhokla, Dahi (Curd), Srikhand. Processing &Preservation methods of Snacks: Gujiya, kachauri, samosa, mirchibada, kofta, potato chips, banana-chips, mathri, bhujiya, fried dhals, bhujia, shakarpara, pakora, vada. Processing & Preservation methods of Baked Products: Biscuits, Toast, Candies, Cookies, Breads, Roti, Naan, Tandoori Roti, parantha, kulcha, puri, bhatura. Processing & Preservation methods of Preserves & Beverages: Murabba, sharbat, pana, aampapad, sharbat, Coconut water, milk (khas, rose), Alcoholic Beverages. Industrialization, Socioeconomic Conditions and Sustainability of Traditional Foods.

**Practical** : To study the effect of different combination of salt and oil in quality of traditional fermented food product (pickle). To study the effect of different starter culture on taste and texture of idli. To evaluate the shelf life of stuffed paratha under different storage conditions. To study the effect of time and temperature on quality of fried food products (poori/ panipoori et. To study effect of sugar and Artificial sweeteners in the preparation of kajukatli. To study the microwave heating in drying of khaman/ dhokla. To study the effect of cold extrusion on mixing of vermicelli. To prepare instantcarrot halwa mix. To study the effect of different packaging material on shelf life of traditional Indianfood products. To study the effect of different natural food preservatives in traditional sweets. Preparation of spiced buttermilk. Preparation of puffed cereals and grains. Preparation and qualityevaluation of Instant Premixes (Puranmix). Preparation of quality evaluation of dried malted moth bean powder. Preparation of Indian traditional confections (chikki). Visit to ethnic food industry (Instant mixes/Pickle making).

**FPT-512 Technologies of Convenience Foods** **2+1 Sem. II**

**Unit I** Overview of grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes Coated grains- salted, spiced and sweetened. Flour based snack– batter and dough-based products; *savoury* and *farsans*;formulated chips and wafers, papads. Fruit and vegetable-based snacks: chips, wafers, papads etc. Coated nuts – salted, spiced and sweetened products- *chikkis, fried groundnut pakora,*

**Unit II** Technology of ready- to- eat baked food products, drying, toasting, roasting and flaking, coating, chipping. Extruded snack foods: Formulation and processing technology, flavouring and packaging

**Unit III** Ready-to-cook food products- different puddings and curried, Vegetables, meat and meat food products etc. Technology of instant cooked rice, carrot and other cereals-based food products Technology of ready to eat instant premixes based on cereals, pulses etc. Technology for RTE puffed snack- sand puffing, hot air puffing, explosion puffing, gun puffing etc.

**Unit IV** Equipment for frying, baking and drying, toasting, roasting and flaking, popping, blending, coating, chipping.

**Practical** : Preparation of cereals based fried snack foods. Preparation of legume based fried snack foods. Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking and their quality evaluation. Preparation of cereal grain based puffed products. To study the effect of frying time and temperature on potato chips. Development of instant food premixes. Preparation of cereal and legume based roasted snack. Preparation of flaked rice product. To study the effect of roasting time and temperature on quality of pop-corn. Determination of shelf-life and packaging requirements of snack food products. Preparation of cereal and legume based roasted snack foods by vacuum frying. Visit to industries manufacturing snack foods.

**FPT-514 Food Ingredients and Additives** **2+1 Sem. I**

**Unit I** Introduction: Role of food ingredients and additives in food processing, functions, classification, intentional and unintentional food additives, toxicology and safety evaluation of food additives, beneficial effects of food additives**,** food additives generally recognized as safe (GRAS), tolerance levels and toxic levels in foods-LD 50 values of food additives. Preservatives: General mechanism of action; basis of selection; classes; Chemical preservatives: characteristics, antimicrobial spectrum, mechanism of action, toxicology, regulations, application in food.

**Unit II** Antioxidants: Characteristics, types/classes/groups, mechanism of action/ working of antioxidants, functions, sources, application in food, limits and toxic effects of synthetic antioxidants, synergistic effects of antioxidants, role of free radicals in human body, Natural antioxidants. Flavouring agents: Flavour functions, selection; forms; sources; process of flavour creation; natural and synthetic flavouring; extractions methods; production process; application in food**.** Stability of flavours during processing, Flavour composites, Flavour emulsions, essential oils, oleoresins, authentication of flavours, Emulsifiers and Stabilizers: Characteristics/ functional properties; functions; basis of selection; types; mechanism of emulsion formation; mechanisms of emulsion stabilization and destabilization; application in food

**Unit III** Hydrocolloids: Definition: function and functional properties: sources; application in food. Sweeteners: Characteristics; classification/types; applications in food; Limits and toxicology of non-nutritive sweeteners. Colouring agents: Properties; functions; classification; sources of natural and synthetic colours: extraction; applications in food, levels of use, misbranded colours, colour stabilization.

**Unit IV** Starch, protein, and lipids, fibres and oligosaccharides, nutraceuticals: As functional ingredients; their isolation, modification, specifications, functional properties and applications in foods. Humectants, clarifying agents, Stabilizers and thickeners, Bleaching and maturing agents, Humectants, Sequestrants / chelating agents, Anti-caking agents, Buffering agents, Acidulants: definition; characteristics; sources; functions and their application in food processing.

**Practical** : Determination of benzoic acid in food samples. Estimation of sulphur dioxide in food samples. Estimation of sorbic acid in cheese and yoghurt. Determination of nitrate and nitrites in foods. Detection and determination of aspartame by thin layer chromatography. Identification of natural colours Isolation,

identification and estimation of synthetic food colours. TLC detection of antioxidants in fats and oils. TLC detection of emulsifiers. Isolation and modifications of protein, starch, lipids, fibres from the raw and processed food samples. Estimation of various additives mentioned in Unit IV. Extraction of essential oil and oleoresin. Applications of additives and Ingredients in foods.

**FPT-517 Enzymes in Food Processing** **2+1** **Sem. II**

**Unit I** Introduction: General Characteristics, Classes and Nomenclature of Enzymes, Mechanism of action, Factors affecting enzyme activity, Enzyme Kinetics. Enzyme Production: Selection and sources of commercial Enzymes, Advantages of microbial enzymes, Problems of scale up, Enzyme extraction and purification methods.

**Unit II** Immobilization: Techniques, advantages and disadvantages, use of immobilized biocatalysts in food processing, Enzymes for protein modification (hydrolysates and bioactive peptides), Enzymes for Lipid modification. Enzymes in cereal processing: Application of enzymes in *process of* malting, brewing, milling, baking (fungal –amylase for bread making; maltogenic – amylases for anti-staling, xylanases and pentosanes, lipases as dough conditioners; oxidases as replacers of chemical oxidants; synergistic effect of enzymes), role of enzymes in production of high fructose corn syrup, glucose syrups.

**Unit III** Enzymes in fruit processing: Applications of enzyme in fruit juice clarification, removal of haziness and bitterness, Uses of enzymes in wine making, Enzymes in meat (tenderization, flavor development, etc.), fish processing (De-skinning, collagen extraction etc.,) and milk processing, Egg processing, Cheese processing.

**Unit IV** Flavour production: Role of enzymes in flavor generation (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides, MSG; flavours from hydrolysed vegetable/animal protein), Enzymes in the processing of fats and oils: specificity, stability and application of lipases and related enzymes, Role of enzymes in hydrolysis of triglycerides, interesterification and randomization. Enzyme allergy.

**Practical** : To study the rate of enzyme catalyzed reaction and enzyme kinetics of common enzymes. To study time course of the reaction catalysed by alkaline phosphatase. To investigate the thermal stability of horseradish peroxidase. Quantitative estimation of endoglucanase. Quantitative estimation of exoglucanase. Quantitative estimation of β galactosidase. Quantitative estimation of Pectinase. Quantitative estimation of Protease. Quantitative estimation of Lipase. Immobilization of amylase by sodium alginate and comparative evaluation with native enzyme. To immobilize yeast cells and demonstrate its biological activity by invertase assay. To study the fermentation process with amylase, protease, and lipase enzyme.

**FPT-519 Zero Waste Processing** **2+0** **Sem. II**

**Unit I** Introduction: Food processing waste and by-product, ISO 14000 for environmental management system, biochemical and nutritional aspects of food processing by-products Waste minimization: Chain management issues and good housekeeping Procedures, minimise energy use in food Processing, minimise water use in food processing

**Unit II** Food waste separation: microbiological risk management, Effects of post harvest changes in quality on the stability of plant co-products, Separation technologies for food wastewater treatment and product recovery

**Unit III** Co-product recovery techniques: Enzymatic extraction and fermentation for the recovery of food processing products, Supercritical fluid extraction and other technologies for extraction of high-value food processing co-products, Membrane and filtration technologies, recovery of nutraceuticals, micronutrients, functional ingredients, Natural dyes

**Unit IV** Waste management and co-product recovery: Meat, cereal, dairy, fish, fruit and vegetable, vegetable oil, plantation crops processing, waste management of food packaging. Food processing waste water treatment and gas production from solid food processing

**FPT-521 Technology of Fruits and Vegetable processing** **2+1** **Sem. I**

Indian and global scenario on production and processing of fruits and vegetables. Quality requirements of raw materials for processing. Post harvest handling, grading and treatments. Storage of fruits and vegetables - controlled atmosphere (CA) and modified atmosphere (MA) storages.

Physiological and enzymological aspects of juice extraction. Fruit and vegetable processing for pulp, puree and concentrates using aseptic packaging, canning, RTS fruit beverages, IQF and frozen fruits and vegetables. Technology for processed products - pickles, chutneys, sauces. Processing of fruits for candies, bars, toffees, jams and jellies, squashes, syrups, cordials, nectars, vinegar and tomato products. Dehydration of fruits and vegetables using various drying technologies. Intermediate moisture fruits and vegetables. Food ingredients and chemicals from fruits, vegetables and their wastes. Effluent treatment. Trends in health aspects related to fruits and vegetables.

**Practical** : Equipment for fruits and vegetables processing. Plant layout. Grading, refrigeration and freezing offruits and vegetables. Evaluation of pectin grade. Canning of fruits and vegetables. Preparation and quality evaluation of fruit jam, fruit jelly, marmalade, preserve and candy, fruit RTS, squash, syrups. Processing of tomato products. Preparation of guava cheese, pickles and chutneys. Preparation of dehydrated vegetables and fruits. Visit to fruits and vegetables. processing factories.

**FPT-522 Technology of Cereals, Pulses and Oil seeds** **2+1** **Sem. I**

Production and utilization trends of different cereal grains. Structure and composition of common cereals, pulses and oil seeds. Wheat- evaluation of varieties, principles of milling, products and by-products, flour treatment, dough rheology, role of enzymes in wheat processing and technology of different bakery products. Rice- classification, milling technology, physico-chemical and cooking quality, accelerated ageing, milled rice products and by-product utilization, parboiling of rice and processed products from rice. Corn- types, milling, manufacture of value added products. Processing of barley, oats, sorghum and millets. Pulses- composition, anti nutritional factors, processing and utilisation. Importance of oil seeds processing industry in India. Processing of edible oils, protein isolates, concentrates and their uses. Extrusion cooking technology. Fermented foods and health foods from grains.

**Practical** : Physico-chemical analysis of grains and resultant flours. Experimental milling. Rheological properties of dough. Test baking. Milling of rice. Physicochemical and cooking quality of rice. Parboiling of rice.Malting of barley. Corn processing. Dehusking of pulses. Preparation of protein concentrates and isolates.Extraction of oil using expeller and solvent extraction methods. Preparation of extruded snacks and pasta products. Visit to related processing industries.

**FPT-523 Technology of Milk and Milk products** **2+1** **Sem. I**

Present status of dairy industry in India and Abroad. Market milk-composition, quality evaluation and testing, procurement, transportation and processing. Cleaning & sanitization of dairy equipments. Fermented and special milks. Probiotic milk products. Technology of commercial manufacture, evaluation and defects of cream, butter, condensed milk, evaporated milk, skim & whole milk powder, ice cream, softy, cheese and yoghurt. Indigenous milk products - khoa, chhana, paneer, dahi and their products, and ghee. Milk by-products. Milk and whey protein concentrates, Lactose and health related other dairy ingredients.

**Practical** : Study on basics of reception of milk at the plant. Platform tests in milk. Estimation of fat and solid not fat (SNF) in milk. Operation of LTLT & HTST pasteurizer. Preparation of special milks. Cream separation & standardization of milk. Preparation and evaluation of table butter, ice-cream, cheese, yoghurt and indigenous milk products. Visit to dairy plants.

**FPT-524 Food Quality Systems and Management** **2+0** **Sem. II**

Concept of quality. Quality attributes of raw and processed food- physical, chemical, nutritional, microbial, and sensory evaluation. Quality management systems- TQM, GMP/GHP, GLP, GAP, HACCP, ISO, Food Codex and Indian food standards. Statistical quality control. Sampling procedures and plans.Food Laws, Food Safety and Standards Act,2006.Labelling issues. International food standards. Quality manual, documentation and audit Export – import policy and export documentation. Laboratory quality procedures and assessment of laboratory performance. Applications in differentfood industries.Food adulteration and food safety. IPR and Patents.

**FPT-591 Seminar** **1+0**

**FPT-599 Master's Research** **0+30**

**Ph.D. courses**

**FPT-601 Novel Technologies for Food Processing and Shelf Life Extension** **3+0** **Sem. I**

Recent advances in novel food processing technologies; Membrane processing, Supercritical fluid extraction, Microwave and radio frequency processing, High Pressure processing, Ultrasonic processing, Ozonization, Plasma Technique, Pulsed electric field processing, Pulsed light technology, Pulsed X-ray processing, Ohmic, inductive, & infra-red heating, Nanotechnology & its food applications, Advanced techniques of flavor stabilization Novel drying techniques, Advanced methods for characterization of processed foods, Concept of shelf life of foods and their classification, factors governing the shelf life of foods, various emerging techniques to increase shelf life of foods, estimation of shelf life of foods, models for predicting the shelf life of foods.

**FPT-603 Food Manufacturing Technology** **3+0** **Sem. II**

Manufacturing resource planning, Product development process - strategy, design, development, commercialization, launch and evaluation. Development of new product, technological knowledge, raw material properties, processing, product qualities, packaging requirement, distribution and marketing. Role of consumers in product development - consumer behavior and food preferences. Inventory control, Production planning, Production scheduling, Material requirement planning, Resource planning, Capacity requirement planning. Job scheduling.

**FPT-604 Plant Food Products** **3+0** **Sem. II**

Food grains – Structure, nutritional composition, processing technology of cereal grains, legume and oilseeds; Post harvest handling of horticultural produce, nutritional composition and processing; Properties and processing of other plant food materials – nuts, coffee, tea and herbs; novel technologies for value addition of plant foods; Alcoholic and non-alcoholic beverages; Packaging, storage stability and quality control of plant food products. Post-harvest handling of fresh fruits and vegetables, Minimally processed fruits and vegetables, advances in chilling, freezing, and drying, Alcoholic and non-alcoholic beverages; Dough quality measurements; bakery, RTE, RTC products; Hydrogenation, fractionation, winterization, interesterification etc. Process for obtaining tailor- made fats and oils; Speciality fats and designer lipids for nutrition and dietetics, Textured Plant proteins.

**FPT-606 Animal Food Products** **3+0** **Sem. II**

Research and development activities on meat, fish and poultry products. Gross and microstructure of muscle, Pre-slaughter care, ante and post mortem, slaughter, handling of offal (edible and inedible). Methods to improve tenderness, Special poultry products, Breaded poultry, packaged precooked chicken, Freeze dried poultry meat. egg preservation, egg powder production. Meat analogues and restructured meat products, production of fish paste, fish oils, sauce, fish protein concentrates. Irradiation of fish and fishery products, packaging of fish products, quality control and quality assurance. Allergens, toxins and infectious diseases from meat, poultry and fish products.

**FPT-608 Carbohydrate Technology** **2+1** **Sem. I**

Introduction to carbohydrate chemistry; Classification of carbohydrates – conventional and non-conventional sources (significance in diet, isolation from natural sources, and changes therein during processing). Chemical & enzymatic modification of carbohydrates especially starches and celluloses, manufacture of maltodextrins and corn syrups, Cyclodextrins - chemistry, technology and food applications. Interactions with other food constituents and their implications; Polysaccharides and gums (xanthan, dextran, pullulan, gellan, curdlan and beta – glucans) nutraceutical and functionalproperties; Stabilization of food systems, simulated and low-fat foods, Fat-substitutes based on carbohydrates, Carbohydrate-based biodegradable packaging. Nutraceutical carbohydrates; Non digestible carbohydrates and their health benefits – resistant starch, prebiotics and oligosaccharides.

**Practical :** Isolation and assay of food carbohydrates. Analysis of modified carbohydrates such as starches and celluloses. Evaluating gelling abilities of different polysaccharides, their blends and the effect of food ingredients such as salts, sugars and acids. Development of food products with newer carbohydrates in relevant food systems.

**FPT-609 Protein Technology** **2+1** **Sem. I**

Protein structure and chemistry; protein -protein interactions, methods of evaluation of protein quality and quantity, Functional properties of proteins, Conventional and novel sources of protein. Production of protein concentrates/isolates from legumes, oilseeds, fish, seafood, leaf, microbes. Functional properties of proteins and their applications; Structure-function relationships of different food proteins, textured vegetable proteins and different methods of texturization. High protein food formulations, Modification of proteins by enzymic (manufacture of protein hydrolysates, their characterization and applications), chemical and physical methods. Interactions of proteins with flavours, polysaccharides, lipids and their technological effects, Protein-based fat substitutes, Protein engineering; Bioactive peptides – classification, production and properties; Nutritional aspects of dietary proteins

**Practical :** Isolation of proteins from different raw materials such as soybeans, oilseed meals, fish, leaves, milk. Preparation of protein isolates, concentrates and hydrolysates and evaluation of their nutritional and functional properties. Development of high-protein food formulations. Visits to industrial units manufacturing protein-based products.

**FPT-610 Advanced Food Analysis 2** **0+2** **Sem. II**

**Practical**

Sample preparation for food analysis. Measurement of colour, viscosity/texture and water activity of raw and processed foods. Rheological techniques and instrumentation in food. Determination of browning reaction, food additives, residues and deleterious factors in raw and processed foods. Enzymatic, Thermal and Chromatographic methods in food analysis. Microscopic, Fluorimetric and polarimetric techniques in food analysis. Application and operating parameters of spectrophotometer, AAS (Atomic absorption spectroscopy), GC (Gas chromatography), HPLC (high performance liquid chromatography), NMR (nuclear magnetic resonance), FTIR (Fourier transform infrared spectroscopy), GC-MS (gas chromatography- mass spectroscopy), LC-MS (liquid chromatography- mass spectroscopy). IR, Raman spectroscopy. SDS gel electrophoresis and molecular weight determination.

**FPT-691 Seminar I** **1+0**

**FPT-692 Seminar II** **1+0**

**FPT-699 Ph.D. Research**

# GENETICS AND PLANT BREEDING

## PROGRAMMES:

**M.Sc Genetics & Plant Breeding**
**Ph.D. Genetics & Plant Breeding**

## COURSE REQUIREMENT

### M. Sc.

| | |
|---|---|
| Field of Specialization | Plant Breeding, Genetics, Cytogenetics |
| Core Courses | GPB-501, GPB-502, GPB-503, GPB-506 |
| Minor Fields | Molecular Biology and Biotechnology, Statistics, Plant Pathology, Entomology, Botany, Biochemistry, Microbiology, Agronomy or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Stat.-502 and courses from subject matter fields (other than Major and Minor) relating to the area of special interest and research problems |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504 and PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduate Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Plant Breeding, Genetics, Cytogenetics |
| Core Courses | GPB-601, GPB-605, GPB-609 |
| Minor Fields | Molecular Biology and Biotechnology, Statistics, Plant Pathology, Entomology, Botany, Biochemistry, Microbiology, Agronomy or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Courses from subject matter fields (other than Major and Minor) relating to the area of special interest and research problems |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduate Studies |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Courses

**PBG 51 Hybrid Seed Production – I** **2+2** **Sem. I**

Hybrid seed production – history, importance, types of hybrids, development of inbred lines, single cross, double cross, three way cross etc. Concept of heterosis and advantages of hybrid cultivars. Systems of pollination control. Male sterility – inheritance, maintenance and utilization of genetic, cytoplasmic and cytoplasmic genetic of male sterility in seed production, sources of male sterility in different crops. Foundation and certified seed production in inbreds, hybrids, synthetics and composites in maize and bajra.

**Practical:** Handling hybrid production programme in maize hybrids - climate, soil, seed source, seed rate and spacing, isolation distance, border rows, planting ratios, methods of planting and earthing up, non-synchronization of flowering, manures, fertilizers and micronutrients, field inspections, weeding, irrigation, pests and diseases, precautions to be taken while detasseling, rouging, harvesting of seed crop, post harvest operations, grading, seed treatment, storage, field standards, seed standards for hybrids, standards for germination test. Hybrid seed production of vegetable crops.

**PBG 52 Seed testing and Quality Control** **2+2** **Sem. I**

Deterioration of crop varieties/hybrids. Factors responsible for loss of genetic purity, maintenance of genetic purity during seed production, safeguards for maintenance of genetic purity. Seed quality standards - Importance of good quality seed, characters of good quality seed, factors affecting seed quality, seed quality components and field standards. Seed sampling. Receipt and registration of samples, Physical purity analysis. Moisture test, Quick viability test. Testing for coated/pelleted seeds. Grow-out test. Seed health including pathogen and insect damage. Seed dormancy, types and methods to break it. Weed seed identification. Seed Act and seed rules and law enforcement. Role of Punjab State Seed certification Authority (PSSCA), Inspection procedures and equipments required.

**Practical:** Sampling and submission of samples to seed testing laboratory, Obtaining working sample, physical purity analysis and reporting results. Germination test Methods of breaking dormancy, Tetrazolium test. Moisture testing. Visit to state seed testing laboratory. Field inspection at different crop growth stages for off types, pollen shedders, designated seed borne diseases, counts of the male and female plants in hybrid seed production, field inspection report for different crops, isolation distances. Seed priming treatment.

**PBG 53 Visits to Seed Production and Processing Units-I** **0+2** **Sem. I**

**Practical:** In order to give a Practical exposure to the students and make them aware of the seed production techniques, the visits will be conducted to: University Seed production Farms at Ladhowal; Private seed growers/progressive farmers; Various organizations in both private/public sectors in order to make them aware of working of seed industry and its problems.

**PBG 54 Project on Seed Production** **0+4** **Sem. I/II**

**Practical:** The class will be divided into groups of 4-5 students each. Each group will be allotted a project(s) on seed production in the hybrids of field and vegetable crops. These groups will be raising the seed crop on their own by Practically doing all the operations from the seed treatment, sowing, inspection, roguing, harvesting, processing, testing and packaging of the seed and finally they will submit a detailed report of the work done. Their performance will be closely monitored and assessed for final evaluation.

**PBG 55 Hybrid Seed Production – II** **2+2** **Sem. II**

Self-incompatibility and its utilization in hybrid seed production. Effect of planting designs on honey bee movements. Variety maintenance. Field inspection, Minimum Field and Seed Certification Standards. Grow-out test. Seed lots, Certified seed label, Certification tag. Validity period of certification.

**Practical:** Handling of Seed production planning in sunflower and summer vegetables with special reference to agronomic practices such as selection of field, seed rate and seed treatment, season and time of sowing, nursery raising, transplanting, optimum stage of harvesting, land and isolation requirements, rouging, harvesting, post harvest operations, grading. Seed treatment, storage, field standards, seed standards for hybrids, standards for germination test. Seed certifications procedures, seed drying, processing, cleaning, testing packaging, storage and marketing.

**PBG 56 Seed health** **2+2** **Sem. II**

Important storage pests namely seedborne plant pathogens (fungi, bacteria, viruses, viroids, nematodes), insects, mites, rodents and birds. Detection of seedborne plathogens and insects. Deterioration of seed due to storage fungi, insects, rodents, birds. Detection of damage and estimation of losses, conditions favouring various storage pests. Pest development and control. Management of insect pests, mites, rodents and birds through seed treatments (biological, chemical, physical and mechanical). Seed certification. Practices for safe storage, examination of seeds for infection with various tests.

**Practical:** Collection and identification of storage insect pests. Fumigation, fumigants, its safe handling and use, plant protection equipments and their use. Examination of seeds for infections. Washing test. Incubation methods. Seedling symptomatology test. Histopathology. NaOH seed-soak method. Collection and identification of storage pests. Dose estimation of various seed protectants. Methods of fumigation, fumigants, its safe handling and use. Plant protection equipment and their use.

**PBG 57 Seed processing and Storage** **2+2** **Sem. II**

Introduction and importance of seed processing. Seed drying, including dehumidification. Seed treatments. Cleaning, grading and processing. Seed storage: Thumb rule and its relevance for seed storage. Seed deterioration. Conservation of orthodox and recalcitrant seeds. Methods to minimize the loss of seed vigour and viability. Storage losses due to pests. Storage methods and godown sanitation. Storage structure. Storage pests and their control.

**Practical:** Operation and handling of mechanical drying equipments. Effect of drying on seed quality during storage. Seed processing equipment. Seed treating equipments. Seed extraction.

**PBG 58 Visits to Seed Production and Processing Units-II** **0+2** **Sem. II**

**Practical:** In order to give a Practical exposure to the students and make them aware of the seed production techniques, the visits will be conducted to:Vegetable Seed Production Programmes under contract growing by NSC in Saparoon valley of Solan or Katrain valley of Kullu.Various processing plants at University Seed Farms/State processing Units and ICAR Regional Research Station, Karnal.

**PBG 59 Elementary Plant Breeding and Seed Production** **2+1** **Sem. I**

Classification of plants, botanical description and floral biology. Emasculation and pollination techniques in cereals, millets, pulses, oilseeds, cotton, sugarcane. Aims and objectives of plant breeding. Modes of reproduction, modes of pollination and their consequences. Mendel's laws of inheritance, qualitative and quantitative traits, genotype and phenotype, cytoplasmic inheritance. Methods of breeding - introduction, selection in self- and cross-pollinated crops. Hybridization and selection in self-pollinated crops. Recurrent selection. Heterosis and inbreeding; hybrid breeding. Methods of breeding asexually propagated crops. Male sterility and its utilization. Importance of seed production. Deterioration of crop varieties and its prevention. Different classes of seed. Production of nucleus and breeder seed. Foundation and certified seed production in self- and cross-pollinated crops. Seed certification. Seed act. Grow out test. Seed drying. Seed testing for quality assessment. Seed health. Seed treatment. Seed storage. Seed marketing.

**Practical:** Botanical description and floral biology of major crops. Hybridization kit. Hybridization techniques in different crops. Study of male sterility and hybrid seed production. Seed sampling. Tests for seed moisture, seed health, seed viability. Test of germination percentage. Grow out test. Varietal identification in seed production plots. Visit to seed processing plant.

## Undergraduate Courses

**PBG 102 Fundamentals of Genetics** **2+1** **Sem. II**

**[For students of B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Horticulture, B.Tech. (Biotechnology) and M.Sc Integrated programme ]**

Pre and Post Mendelian concepts of heredity. Mendelian principles of heredity. Architecture of chromosome - morphology, karyotype and ideogram. Special types of chromosomes. Chromosomal Theory of inheritance. Cell cycle and cell division (mitosis and meiosis). Probability and Chi-square test. Dominance relationships. Epistatic interactions with example. Multiple alleles - blood group genetics, pleiotropism and pseudoalleles. Sex determination, sex linkage, sex limited and sex influenced traits. Linkage and its estimation. Crossing over mechanisms. Chromosome mapping. Structural and numerical variations in chromosome and their implications (genetic disorders). Use of haploids, dihaploids and doubled haploids in genetics. Mutation - classification, methods of inducing mutations, CIB technique, mutagenic agents. Qualitative and quantitative traits - polygenes and continuous variations, multiple factor hypothesis. Cytoplasmic inheritance. Nature, structure and replication of genetic material. Protein synthesis, transcription and translational mechanism of genetic material. Gene concept - gene structure, function and regulation, *Lac* and *Trp* operons.

**Practical:** Use of microscope. Study of cell structure. Mitosis and meiosis. Experiments on monohybrid, dihybrid, test cross and back cross. Experiments on epistatic interactions including test cross and back cross. Practice on mitotic and meiotic cell division. Experiments on probability and Chi-square test. Determination of linkage and cross-over analysis (through two-point test cross and three-point test cross data). Study on sex linked inheritance in *Drosophila.* Study of models on DNAand RNA structures.

**PBG 103 Introduction to Genetics and Plant Breeding** **1+1** **Sem.II**

**[For students of B.Sc.(Hons.) Agribusiness Management]**

History of Genetics & Plant Breeding, Study of Chromosome- Structure, functions, cell division. Mendel's laws of inheritance, Mode of inheritance- monogenic, polygenic, cytoplasmic. Modes of reproduction in plants: sexual and asexual, differences between self and cross pollinated crops. Male sterility and their significance in plant breeding. Breeding for self-pollinated (Mass, pureline, pedigree and bulk methods), cross pollinated (Ear to row, Backcross, Development of synthetics, composites and hybrids), vegetabively propagated crops viz., Clonal selection.

**Practical:** Microscopy, Mendelian ratios- Monohybrid and dihybrid, and problems related to segregation and independent assortment and polygenic inheritance. Mitiosis and meiosis crossing over percentage, map distance.Study of floral biology and structure of a model flower, study of floral structure and biology of important cereals, pulses, oilseeds and commercial crops. Study of plant breeders kits,selfing and crossing techniques. Male sterility: A, B and R lines and their utility in hybrid seed production. Pollen fertility study and its importance.Principles of field experimental design.Layout of field experiments, principles, data recording.Analysis of RBD.Visit to different crop breeding schemes.

**PBG 201 Fundamentals of Plant Breeding** **2+1** **Sem. I**

**[For Students of B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Horticulture,B.Tech.(Biotechnology]**

Historical development, concept, nature and role of plant breeding. Major achievements and future prospects. Genetics in relation to plant breeding. Modes of reproduction. Male sterility - genetic consequences and cultivar options. Domestication, acclimatization and introduction. Centres of origin/ diversity. Components of genetic variation, heritability and genetic advance. Genetic basis and breeding methods in self-pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population. Multiline concept. Concepts of population genetics and Hardy-Weinberg Law. Genetic basis and methods of breeding in cross - pollinated crops. Modes of selection. Population improvement schemes - ear to row method, modified ear to row, recurrent selection schemes. Heterosis and inbreeding depression. Development of inbred lines and hybrids, composite and synthetic varieties. Breeding methods in asexually propagated crops - clonal selection. Wide hybridization and pre-breeding. Polyploidy in relation to plant breeding. Mutation breeding - methods and uses. Breeding for important

biotic and abiotic stresses. Introduction to biotechnological tools - DNA markers and marker assisted selection. Participatory plant breeding. Plant Breeders' and Farmers' Rights.

**Practical:** Plant breeder's kit. Study of germplasm of various crops. Study of floral structure of self-pollinated and cross-pollinated crops. Emasculation and hybridization techniques in self and cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Maintenance of breeding records and data collection. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. Working out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

**PBG 301 Crop Improvement – I (*Kharif* Crops) 1+1 Sem. I**

**[For students of B.Sc. (Hons.)Agriculture, and B.Tech.(Biotechnology) - In collaboration with Department of Fruit Science & Vegetable Science]**

Centre of origin, distribution of species, wild relatives, utilization and conservation of plant genetic resources, major breeding objectives and procedures, study of genetics of qualitative and quantitative characters, innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional) in rice, maize, pigeonpea, mungbean, soybean, groundnut, castor, cotton, jute, sorghum, pearl millet, tobacco, brinjal, okra, muskmelon, guava and banana. Ideotype concept and climate resilient crop varieties for future.

**Practical:** Floral biology and crossing techniques in rice, maize, cotton, pearl millet, pigeonpea, mungbean, soybean, groundnut, brinjal, okra, muskmelon/bottle gourd, guava and banana. Maintenance breeding in different *kharif* crops. Study of field techniques for seed production. Hybrid seed production technologies in maize, cotton, rice and brinjal. Estimation of heterosis and inbreeding depression. Layout of field experiments. Study of quality traits. Important donors for different characters. Visit to seed production farms and research experiments.

**PBG 302 Crop Improvement – II (*Rabi* Crops) 1+1 Sem. II**

**[For students of B.Sc. (Hons.)Agriculture and B.Tech.(Biotechnology) - In collaboration with Department of Fruit Science & Vegetable Science]**

Centre of origin, distribution of species, wild relatives, utilization and conservation of plant genetic resources, study of genetics of qualitative and quantitative characters, major breeding objectives and procedures, innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional) in wheat, barley, chickpea, lentil, rapeseed mustard, sunflower, sugarcane, oat, berseem, potato, chilli, onion, mango and citrus. Ideotype concept and climate resilient crop varieties for future.

**Practical:** Floral biology and crossing techniques in wheat, barley, rapeseed mustard, sunflower, sugarcane, chickpea, lentil, oat, berseem, potato, tomato chilli and onion. Maintenance breeding in different rabi crops. Study of field techniques for seed production. Hybrid seed production technologies in sunflower, mustard and chilli. Estimation of heritability. Layout of field experiments. Study of quality traits. Important donor parents for different characters. Visit to seed production farms and research experiments.

**PBG 303 Intellectual Property Rights 1+0 Sem. I**

**(For students of B.Sc.(Hons.)Agricultureand B.Sc.(Hons.)Agribusiness Management)**

Introduction to IP, GATT, WTO, TRIPs and WIPO. Treaties for IPR protection- Madrid protocol, Berne Convention, Budapest treaty, etc. Types of IP and legislations covering IPR in India- patents, copyrights, trademark, industrial design, geographical indications, integrated circuits, trade secrets. Patent Act 1970 and patent system in India. Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002and its salient features, access and benefit sharing. Introduction to UPOV and PPV & FR Act 2001, access and benefit sharing. Breeders, researchers and farmers rights along with protection of plant varieties. Traditional knowledge-meaning and rights of TK holders.

**PBG 304 Principles of Seed Technology 1+1 Sem. II**

Seed and seed technology - Introduction and importance. Causes of deterioration of crop varieties and their control. Maintenance of genetic purity during seed production. Seed quality - definition, characters of good quality seed. Different classes of seed. Foundation and certified seed production of important crops. DUS testing. Seed certification - phases, procedure and field inspection. Seed laws and its enforcement. Duties and powers of seed inspector, offences and penalties. Seed Control Order 1983. Seed production of non-GM crops. GM crops and organic seed production. Contamination by transgenes. Seed drying and processing. Seed testing for quality assessment. Seed treatment - importance, method of application and seed packing. Seed storage - general principles, stages and factors affecting seed longevity, measures for pest control. Seed marketing - structure and organization, sales generation activities, promotional media, factors affecting seed marketing, role of WTO and OECD. Private and public sectors - production and marketing strategies.

**Practical:** Seed production in wheat, maize, mungbean, chickpea, rapeseed-mustard, sunflower, chilli and onion. Seed sampling and testing - physical purity, moisture content, germination, viability, seedling vigour. Genetic purity test - grow out test and DNA fingerprinting. Seed certification - procedure, field inspections and preparation of reports. Visit to seed production farms and seed testing laboratories.

**PBG 305 Molecular Breeding Technologies 2+1 Sem. II**

**(In collaboration with School of Agricultural Biotechnology)**

**(Optional course)**

Limitations of conventional breeding strategies. Conventional and advanced Mapping populations $F_2$, DH, RILs, BC, NILs, NAM, MAGIC. Molecular markers- RFLP, RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their applications. Development of linkage maps. Bulked Segregant Analysis and mapping genes for qualitative traits. Quantitative traits and mapping QTLs. Marker assisted selection and pyramiding. Commercial applications and success stories of Marker Assisted Selection. Introduction to genome sequencing platforms. Impact of genome sequencing on plant breeding. Genome editing and future of plant breeding. Doubled haploid breeding in cereals. Speed breeding in cereals.

**Practical:** DNA extraction. Assessing quality and quantity of DNA. Polymerase chain reaction, Agarose gel electrophoresis. DNA fingerprinting-hybrid purity and variety protection. Assessment of genetic diversity using SSR markers. Development of linkage maps using MapMaker. QTL mapping using WinQTL cartographer. Visit to genome sequencing facilities at other institutes. Introduction to Linux terminal. BLAST. Primer designing.

**PBG 306 Principles and Practices of Seed Science and Technology 1+1 Sem. II**

**[For students of B.Sc.(Hons.) Agribusiness Management]**

Introduction: Importance of improved seed in Indian Agriculture, definition, difference between seed and grain, characteristics of quality seed. History: Development of seed industry in India. Seed Programme: Types of seed programme, development of seed programme, basic strategy for organizing seed production, different classes of seeds, seed replacement rate, agencies involved in seed programme. Principles of seed production: Factors affecting genetic purity and varietal deterioration, methods / safe guards to maintain genetic purity during seed production, study of improved production practices for higher seed yield and quality. Economic principles: Study of SMR, importance of SMR, SMR in different crops. Hybrid seed production: Requirements and methods of hybrid seed production. Varietal and hybrid seed production (Foundation and Certified seed classes) in important crops, minimum seed standards for certification. Seed processing and packaging: Seed processing- its importance and methods. Seed packaging and seed branding.

**Practical:** Identification of seeds and seed production in wheat, maize, mungbean, chickpea, rapeseed-mustard, sunflower, chilli and onion. Types of isolation, determination of isolation distance, requirements, study of isolation requirements in different crops for foundation and certified seeds. Study of distinguishing morphological characters in A, B &R lines of released hybrids. Study of synchronization techniques for hybrid seed production, planting ratio. Seed sampling and testing - physical purity, moisture content, germination, viability, seedling vigour. Genetic purity test - grow out test and DNA fingerprinting. Study of

seed cleaning and grading technique, seed packing and seed treatment techniques. Working out cost of seed production, seed pricing. Visit to seed production farms and seed testing laboratories.

**PBG 491 Agro-industrial Attachment** **0+4** **Sem. I**

**Practical:** Commercial Hybrid Seed Production Units

**PBG 492 Experiential Learning in Seed Production and Technology** **0+20** **Sem II**

## Postgraduate Courses

**GPB-501 Principles of Genetics** **2+1** **Sem. I**

**Unit I** Beginning of genetics, early concepts of inheritance. Mendel's laws. Discussion on Mendel's paper. Chromosomal Theory of inheritance. Cell structure and cell division. Multiple alleles. Gene interactions. Sex determination, differentiation and sex-linkage. Sex-influenced and sex-limited traits. Linkage-detection methods and estimation. Crossing over, recombination and genetic mapping in eukaryotes. Somatic cell genetics. Extra chromosomal inheritance.

**Unit II** Mendelian population, Random mating population, Frequencies of genes and genotypes, Hardy- Weinberg equilibrium and factors affecting Hardy- Weinberg equilibrium.

**Unit III** Nature, structure and organization of DNA in chromosomes. Replication of the genetic material in prokaryotes and eukaryotes. Transcription and RNA processing. Genetic code. Protein biosynthesis and post translational modifications. Benzer's fine structure of gene. Allelic complementation. Split genes. Overlapping genes. Pseudogenes. Oncogenes. Gene families and clusters. Gene regulation in prokaryotes and eukaryotes. Molecular chaperones and gene expression. RNA editing. Anti- sense RNA and ribozymes. MicroRNAs (miRNAs). Molecular mechanisms of mutation, repair and suppression. Bacterial plasmids. Insertion (IS) and transposable (Tn) elements. Gene silencing. Genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders.

**Unit IV** DNA restriction and modification, Construction of genomic and cDNA libraries. Gene isolation, synthesis and cloning. Positional cloning of gene. Nucleic acid hybridization and immunochemical detection. DNA sequencing, Chain termination and chemical degradation methods.

**Unit V** Introduction to genomics and proteomics. Metagenomics. Transgenic bacteria and bioethics.

**Practical :** Studies on mitosis and meiosis in selected crops. Laboratory exercises in probability and chi-square. Demonstration of genetic principles using laboratory organisms. Chromosome mapping using two point and three-point test crosses., Demonstration of softwares for preparation of linkage map. Tetrad analysis, Induction and detection of mutations through genetic tests. Problems on Hardy Weinberg equilibrium. DNA extraction and PCR amplification. Electrophoresis: basic principles and running of amplified DNA. Extraction of proteins and isozymes. Use of Agrobacterium mediated method and Biolistic gun: Practical demonstrations. Detection of transgenes in the exposed plant material. Visit to transgenic glasshouse and learning the Practical considerations.

**GPB-502 Principles of Plant Breeding** **2+1** **Sem. I**

**Unit I** Early Plant Breeding. Accomplishments through plant breeding. Objectives and scope of plant breeding. Patterns of Evolution in Crop Plants. Reproduction and pollination systems in plants. Centre of Origins. Law of parallel variation. Agro-biodiversity and its significance. Pre-breeding: evaluation and utilization of germplasm. Plant introduction. Role of plant genetic resources in plant breeding.

**Unit II** Genetic basis of breeding: self and cross pollinated crops including mating systems and response to selection. Nature of variability, components of variation. Heritability and genetic advance, genotype environment interaction. General and specific combining ability. Types of gene actions and implications in plant breeding.

**Unit III** Pure line Theory, pure line and mass selection methods, pedigree, bulk, backcross, single seed descent and multiline breeding. Population breeding in self-pollinated crops with special reference to diallel selective mating. Transgressive breeding.

**Unit IV** Genetic structure of cross pollinated crops. Hardy Weinberg Law. Breeding methods in cross pollinated Crops: mass selection and ear-to-row method. S1 and S2 progeny testing. Progeny selection schemes: recurrent selection schemes for intra and inter-population improvement. Development of synthetics and composites. Hybrid breeding: genetic and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance. Seed production of hybrid seed and their parent varieties/inbreds. Self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.

**Unit V** Breeding methods in asexually/clonally propagated crops, clonal selection.

**Unit VI** Special breeding techniques: Mutation breeding. Breeding for abiotic and biotic stresses. Concept of plant ideotype and its role in crop improvement. Concept of MAS. Concept of polyploidy and wide hybridization. Doubled haploidy.

**Unit VII** Cultivar development: testing, release and notification. Maintenance Breeding. Participatory Plant Breeding. Plant breeders' rights and regulations for plant variety protection and farmers rights.

**Practical :** Floral biology in self- and cross-pollinated species. Selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material. Layout of experiments and experimental designs. Analysis of variance (ANOVA). Estimation of heritability and genetic advance. Maintenance of experimental records. Learning techniques in hybrid seed production using male- sterility in field crops. Prediction of performance of double cross hybrid.

**GPB-503 Fundamentals of Quantitative Genetics** **2+1** **Sem. II**

**Unit I** Introduction and historical background of quantitative genetics. Multiple factor hypothesis. Qualitative and quantitative characters. Analysis of continuous variation: mean, range, SD, CV. Components of variation- Phenotypic, Genotypic. Nature of gene action- additive, dominance and epistatic, linkage effect. Principles of analysis of variance and linear model. Expected variance components. Random and fixed effect model. Comparison of means and variances for significance.

**Unit II** Designs for plant breeding experiments- principles and applications. Variability parameters, concept of selection. Simultaneous selection methods and selection of parents. MANOVA.

**Unit III** Association analysis- Genotypic and phenotypic correlation. Path analysis. Discriminate function and principal component analysis. Genetic divergence analysis- Metroglyph and D2. Generation mean analysis. Parent progeny regression analysis.

**Unit IV** Mating designs- classification, Diallel, partial diallel, L x T, NCDs, and TTC. Concept of combining ability and gene action, G x E interaction-Adaptability and stability. Methods and models of stability analysis. Bi-plot analysis: GGE biplot and AMMI, principles and interpretation.

**Unit V** Molecular markers, concept and development. QTL mapping, Strategies for QTL mapping: desired population and statistical methods. Marker assisted selection for quantitative traits and factors influencing the MAS. Simultaneous selection based on marker and phenotype.

**Practical** : Analysis and interpretation of variability parameters. Lattice designs and field layouts. Analysis and interpretation of Index score and Metroglyph. Clustering and interpretation of D2 analysis. Genotypic and phenotypic correlation analysis. Path coefficient analysis. Estimation of different types of heterosis, inbreeding depression. A, B and C Scaling tests. L x T analysis. Use of computer packages. Diallel analysis. G X E interaction and Stability analysis. Development of Saturated linkage map. QTL analysis.

**GPB-504 Varietal Development and Maintenance Breeding** **1+1** **Sem. II**

**Unit I** Definition: variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, landraces, hybrid, and population. Breeding scheme for varietal development in self and cross pollinated crops. Variety testing, release and notification systems and norms in India and abroad.

**Unit II** DUS testing: DUS Descriptors for major crops. Genetic purity concept and maintenance breeding. Maintenance of varieties in self and cross pollinated crops, isolation distance.

**Unit III** Factors responsible for genetic deterioration of varieties - safeguards during seed production. Principles of seed production. Methods of nucleus and breeder seed production. Generation system of seed multiplication- nucleus, breeders, foundation, certified.

**Unit IV** Quality seed production technology of self and cross pollinated crop varieties viz. cereals & millets(wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.), Pulses (green gram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil), Oilseeds (groundnut, soybean, sesame, castor,sunflower, safflower, linseed, rapeseed and mustard), fibres (cotton/jute) and forages (guar, foragesorghum, teosinte, oats, berseem, lucerne).

**Unit V** Seed certification procedures. Seed laws and acts, plant variety protection regulations in India andinternational systems.

**Practical :** Identification of suitable areas/locations for seed production. Ear-to-row method and nucleus seed production. Male sterility system for hybrid seed production. PGMS and TGMS. Hybrid seed production technology of important crops. Identification of important weeds/objectionable weeds. Determination of isolation distance and planting ratios in different crops. Seed production techniques of varieties in different crops. Main characteristics of released and notified varieties, hybrids and parental lines. DUS testing and descriptors in major crops. Variety release proposal formats in different crops.

**GPB-505 Principles of Cytogenetics** **2+1** **Sem. I**

**Unit I** Architecture of chromosomes in prokaryotes and eukaryotes- chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere. Artificial chromosome construction and its uses. Special types of chromosomes. Cell cycle- mitosis and meiosis. Synaptonemal complex. Recombination models. Introduction to techniques for karyotyping (chromosome banding and in situ hybridization): principle, methodology and various applications.

**Unit II** Symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids. Structural (deletions, duplications, inversions and translocations) and numerical variations (trisomics, tetrasomics, monosomics and nullisomics) of chromosomes and their implications- production, meiotic and breeding behaviour, utilization in gene location. Somatic segregation and chimeras, endomitosis and somatic reduction. Evolutionary significance of chromosomal aberrations. Balancedlethal and chromosome complexes. Inter-varietal chromosome substitutions.

**Unit III** Ploidy manipulations- haploidy and polyploidy. Haploidy: production and use of haploids, dihaploids and doubled haploids in genetics and plant breeding. Polyploidy: production, reversion of autopolyploids to diploids, genetic consequences of polyploidization, genome mapping in polyploids, role of polyploids in crop breeding, evolutionary advantages of autopolyploids vs allopolyploids.

**Unit IV** Fertilization barriers in crop plants at pre-and post fertilization levels in wide hybridization, in vitro techniques to overcome the fertilization barriers in crops. Interspecific hybridization and allopolyploids. Hybrids between species with same chromosome number, hybrids between species with different chromosome number. Synthesis of new crops (wheat, triticale, brassica, and cotton). Whole chromosome alien addition and substitution lines and chromosome segmental substitutionlines- creation and utilization. Gene transfer using amphidiploids, bridging species.

**Unit V** Chromosome manipulations in wide hybridization: case studies. Apomixis- cytology, genetics andrelation with natural polyploids, evolutionary and genetic problems in crops with apomixis.

**Practical :** Learning the cytogenetics laboratory. Microscopy: various types of microscopes. Preparing specimen for observation. Fixative preparation and fixing plant specimens for light microscopy studies. Various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. Studies on mitosisand meiosis in crop plants. Using micrometers and studying the pollen grain size in various crops. Pollen germination in vivo and in vitro. Induction and identification of haploids and polyploids in crops. Cytological observations on various cytogenetic stocks (wide hybrids, aneuploids and synthetic polyploids). Maintenance of cytogenetic stocks. Fluorescent and genomic in situ hybridization (FISH& GISH).

**GPB-506 Molecular Breeding and Biotechnology** **2+1** **Sem. II**

**Unit I** Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), Functional markers. Mapping populations (F2s, back crosses, RILs, NILs and DH): concepts and development. Concept of Bulk Segregant analysis. Estimation of recombination frequency and mapping functions. Development of molecular linkage maps. Molecular mapping of a gene/QTL.

**Unit II** Allele mining. Tilling and Ecotilling. Marker-assisted selection for qualitative and quantitative traits. Marker-assisted backcross breeding for rapid introgression. Genomics- assisted breeding. Generation of EDVs. Gene pyramiding.

**Unit III** Introduction to Comparative Genomics. Large scale genome sequencing strategies. Human genome project. Arabidopsis genome project. Rice genome project. Comparative genomics tools. Introduction to proteomics: 2D gel electrophoresis. Chromatography & sequencing by Edman degradation & mass spectrometry.

**Unit IV** Recombinant DNA technology. Transgenes. Method of transformation. Selectable markers and clean transformation techniques. Vector-mediated gene transfer. Physical methods of gene transfer. Production of transgenic plants in important field crops and commercial releases. Barnase/Barstar system for hybrid seed production. Molecular farming. Application of Tissue culture in molecular breeding. GMO-International regulations, biosafety issues of GMOs. Regulatory procedures in major countries including India, ethical, legal and social issues. Introduction to bioinformatics: bioinformatics tools, biological data bases (primary & secondary), implications in crop improvement.

**Practical :** Requirements for plant tissue culture laboratory. DNA isolation, DNA purity and quantification tests. PCR-based DNA markers, gel scoring and data analysis for phylogenetic relationship. Construction of genetic linkage maps and gene/QTL mapping. Gel electrophoresis of proteins and isozymes. Techniques in plant tissue culture: Media components and media preparation. Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretations. Agrobacterium mediated transformation. GUS assay in transformed cells/tissues. Inoculation of explants, callus induction, plant regeneration and hardening of regenerated plants. Establishing a greenhouse and hardening procedures. Visit to commercial micropropagation unit. NCBI Genomic Resources, GBFF, Swiss Prot, Blast n / Blast p, Gene Prediction Tool, Expasy Resources, PUBMED & PMC, OMIM & OMIA, ORF finder. Comparative Genomic Resources:- Map Viewer (UCSC Browser & Ensembl). Primer designing- Primer 3 / Primer BLAST.

**GPB-507 Breeding for Quality and Special Traits** **2+1** **Sem. I**

**Unit I** Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, amino acids and anti-nutritional factors. Nutritional improvement: A human perspective.

**Unit II** Breeding for grain quality parameters in rice and its analysis. Golden rice and aromatic rice: Breeding strategies, achievements and application in Indian context. Molecular basis of quality traits and their manipulation in rice. Post-harvest manipulation for quality improvement. Breeding strategies for chapati and baking qualities in wheat. Molecular and cytogenetic manipulation for quality improvement in wheat.

**Unit III** Breeding for quality improvement in Sorghum, pearl millet, barley and oats. Quality protein maize, specialty corns, concept and breeding strategies. Breeding for quality improvement in important forage crops for stay green traits. Genetic resource management for sustaining nutritive quality in crops.

**Unit IV** Breeding for quality in pulses – Chickpea, pigeonpea, green gram and black gram cooking quality, Breeding for quality in oilseeds: groundnut, mustard, soybean, sesame, sunflower and safflower. Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops. Genetic manipulation for quality improvement in cotton, sugarcane and potato

**Unit V** Genetic engineering protocols for quality improvement: Achievements made. Biofortification in crops, classification and importance, nutritional genomics and second generation transgenics.

**Practical :** Grain quality evaluation in rice. Correlating ageing and quality improvement in rice. Quality parameters evaluation in wheat, pulses, oilseeds and millets. Estimation of anti-nutritional factors in different varieties/hybrids. Evaluation of quality parameters in cotton, sugarcane and potato. Value addition in crop

plants. Post-harvest processing of major field crops. Quality improvement in crops through tissue culture techniques. Evaluating the available populations like RIL, NIL etc. for quality improvement using MAS procedures. Successful examples of application of MAS for quality trait in rice, mustard, maize etc.

**GPB-508 Mutagenesis and Mutation Breeding** **2+1** **Sem. I**

**Unit I** Mutation and its history. Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations. Detection of mutations. Paramutations in crops plants.

**Unit II** Mutagenic agents: physical– radiation types and sources. Ionizing and non-ionizing radiations. Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships. Effect of mutations on DNA – repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects. Dosimetry-Objects and methods of treatment. Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects. Radiation sensitivity and modifying factors: External and internal sources: Oxygen, water content, temperature and nuclear volume.

**Unit III** Chemical mutagens: Classification – base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action. Dose determination and factors influencing chemical mutagenesis. Treatment methods using physical and chemical mutagens. Other causes of mutation – direct and indirect action, comparative evaluation of physical and chemical mutagens.

**Unit IV** Observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras etc. Observing mutagen effects in M2 generation. Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations. Mutations in traits with continuous variation. Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage etc. Individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation. Comparative evaluation of physical and chemical mutagens for creation of variability in the some species- Case studies.

**Unit V** Use of mutagens in creating oligogenic and polygenic variations – Case studies. In vitro mutagenesis: Callus and pollen irradiation. Handling of segregating M2 generations and selection procedures. Validation of mutants. Mutation breeding for various traits (disease resistance, insect resistance, quality improvement etc.) in different crops. Procedures for micromutations breeding/ polygenic mutations. Achievements of mutation breeding- varieties released across the world, problems associated with mutation breeding. Use of mutagens in genomics, allele mining, TILLING.

**Practical :** Precautions on handling of mutagens. Dosimetry-Studies of different mutagenic agents: Physical mutagens and Chemical mutagens. Learning about gamma chamber and inducing mutations using gamma radiations. Radiation hazards: Monitoring- safety regulations and safe transportation of radioisotopes, visit to radio isotope laboratory, learning on safe disposal of radioisotopes. Treating the plant propagules at different doses of chemical mutagens. Procedures in combined mutagenic treatments. Raising the crop for observation. Mutagenic effectiveness and efficiency: calculation of LD50 value. Study of M1 generation- Parameters. Study of M2 generation- Parameters. Mutation breeding in cereals and pulses-achievements made and an analysis. Mutation breeding in oilseeds and cotton- achievements and opportunities. Mutation breeding in forage crops and vegetatively propagated crops. Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

**GPB-509 Hybrid Breeding** **2+1** **Sem. I**

**Unit I** Historical and evolutionary aspects of heterosis. Nomenclature and definitions of heterosis. Genetic consequences of selfing, sib-mating and crossing in self-and cross-pollinated and asexually propagated crops. Heterosis in natural population and inbred population. Genetic theories of Heterosis, Physiological, biochemical, molecular and biometrical basis of heterosis. Estimation of heterosis.

**Unit II** Prediction of heterosis from various crosses. Inbreeding depression, coefficient of inbreeding and its estimation, residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis- case studies. Relationship between genetic distance and expression of heterosis-

case studies. Divergence and genetic distance analyses, morphological and molecular genetic distance in predicting heterosis. Development/enrichment of heterotic pools for extracting superior inbreds.

**Unit III** Male sterility and use in heterosis breeding. Development of male sterile line and diversification in self-pollinated, cross pollinated and asexually propagated crops. Creation of male sterility through genetic engineering and its exploitation in heterosis. Maintenance, transfer and restoration of different types of male sterility. Use of self-incompatibility in development of hybrids.

**Unit IV** Hybrid seed production system: 3-line, 2-line and 1-line system. Development of inbreds and parental lines- A, B and R lines. Functional male sterility. Commercial exploitation of heterosis. Maintenance breeding of parental lines in hybrids. Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops, problems and prospects. Apomixis in fixing heterosis- concept of single line hybrid. Organellar heterosis and complementation.

**Unit V** Hybrid breeding in wheat, rice, cotton, maize, pearl millet, sorghum, rapeseed- mustard, sunflower, safflower, castor and pigeonpea.

**Practical :** Characterization of male sterile lines using morphological descriptors. Restorer line identification and diversification of male sterile sources. Development of male sterile line in crop plants, problems in creation of CGMS system, ways of overcoming them. Success stories of hybrid breeding in Maize, Rice, pearl millet, Sorghum and Pigeonpea. Understanding the difficulties in breeding apomicts. Estimation of heterotic parameters in self, cross and asexually propagated crops. Estimation from the various models for heterosis parameters. Hybrid seed production in field crops– an account on the released hybrids, their potential, problems and ways of overcoming it. Hybrid breeding at National and International level, opportunities ahead.

**GPB-510 Seed Production and Certification** **1+1** **Sem. I**

**Unit I** Importance of seed as basic input in agriculture. Seed quality concept and importance. Generation system of seed multiplication -Varietal replacement rate, Seed multiplication ratios, Seed replacement rate, Seed renewal period and seed demand and supply. Various factors influencing seed production –Physical and Genetic purity in seed production. Factors responsible for varietal and genetic deterioration.

**Unit II** Nucleus seed production and its maintenance- Maintenance of parental lines of hybrids. Production of breeder, foundation and certified seed and their quality maintenance. Principles of seed production in self- and cross-pollinated crops. Hybrid seed production- system and techniques involved in Seed village concept. Organic seed production & certification.

**Unit III** Principles of seed production in field crops. Floral structure, pollination mechanism and seed production techniques in self- & cross-pollinated cereals and millets.

**Unit IV** Floral structure, pollination mechanism and methods and techniques of seed production in major pulses & oilseed crops. Varietal and hybrid seed production techniques in Pigeon pea, Mustard, Castor & Sunflower.

**Unit V** Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibres. Hybrid-seed production techniques in major vegetatively propagated crops.

**Unit VI** Seed certification - history, concept, objectives. Central seed certification board Seed certification agency / organization and staff requirement. Legal status- Phases of seed certification, formulation, revision and publication of seed certification standards. Minimum Seed Certification Standards (MSCS) for different crops- General and specific crop standards, Field and seed standards. Planning and management of seed certification programs. Eligibility of a variety for certification, area assessment, cropping history of the seed field.

**Practical :** Planting design for variety- hybrid seed production techniques, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony. Identification of rogues and pollen shedders, supplementary pollination, detasseling, hand emasculation and pollination. Pollen collection and storage methods, pollen viability and stigma receptivity. Pre-harvest sanitation, maturity symptoms, harvesting techniques. Visits to seed production plots - visit to seed industries. Planning for seed production: cost benefit ratio, seed multiplication ratio & seed replacement rate. General procedure

of seed certification, identification of weed and other crop seeds as per specific crops, field inspection at different stages of a crop and observations recorded on contaminants and reporting of results, inspection and sampling, harvesting/threshing, processing and after processing for seed law enforcement; for tags and labels to be used for certification purpose.

**GPB-511 Crop Breeding-I (*Kharif* Crops) 2+1 Sem. I**

**Unit I** Rice and Maize: Origin, evolution, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, wide hybridization and introgression of alien gene(s), biotic and abiotic stress resistance, heterosis breeding, released varieties, important examples of MAS, Aerobic rice and its implications. QPM and Bt maize – strategies and implications.

**Unit II** Small millets: Evolution and distribution of species and forms-wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives and breeding approaches.

**Unit III** Pigeon pea, Urdbean, Mungbean and Soybean: Evolution, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, wide hybridization and introgression of alien gene(s), biotic and abiotic stress resistance, heterosis breeding and hybrid seed production, released varieties, important examples of MAS. Progress made at National and International institutes.

**Unit IV** Groundnut, castor and Sesame: Origin, evolution, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, wide hybridization and introgression of alien gene(s), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Hybrid breeding in castor– opportunities, constraints and achievements.

**Unit V** Cotton, Jute and Sugarcane: Origin, evolution, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, introgression of alien gene(s), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Bt hybrids- development and maintenance of male sterile lines, seed production. Evaluation procedures for Bt cotton.

**Unit VI** Pearl millet, Sorghum, Fodder Maize and Napier Bajra: Evolution and distribution of species and forms – wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives and breeding approaches.

**Practical :** Floral biology, emasculation, pollination techniques and study of segregating generations in rice, maize, pigeon pea, mungbean, soybean, groundnut, sesame, cotton, sugarcane, pearlmillet and sorghum. Study of range of variation for yield and yield components. Attempting interspecific crosses in rice and mungbean. Evaluating the germplasm of cotton for yield, quality and resistance parameters. Learning the procedures on development of Bt cotton. Visit to Cotton Technology Laboratory and Spinning Mills. Learning on the Standard Evaluation System (SES) and descriptors. Use of software for database management and retrieval. Identification of different annual and perennial species of fodder crops. Evaluation the germplasm of fodder crops for yield, yield attributes and biotic stresses. Laboratory analysis of forage crops for crude protein, digestibility percent and quality attributes. Learning experience on preservative technology of different fodder crops. Visit to animal feed producing factories.

**GPB-512 Crop Breeding-II (*Rabi* Crops) 2+1 Sem. II**

**Unit I** Wheat and Barley: Origin, evolution, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, introgression of alien gene(s), biotic and abiotic stress resistance, heterosis breeding, released varieties, Important examples of MAS used for improvement.

**Unit II** Chickpea, Lentil, field pea, Rajma, Horse gram: Origin, evolution mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, introgression of alien gene(s), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

**Unit III** Rapeseed, Mustard, Sunflower and Safflower: Origin, evolution, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, introgression of alien gene(s), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Oil quality, Improvement for oil quality.

**Unit IV** Mesta: Origin, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, introgression of alien gene(s), biotic and abiotic stress resistance, released varieties.

**Unit V** Berseem, Oats and Rye grass: Origin, evolution, mode of reproduction, chromosome number, cytogenetics and genome relationship, breeding objectives and breeding approaches, introgression of alien gene(s), biotic and abiotic stress resistance.

**Practical :** Floral biology, emasculation and pollination techniques and study of segregating populations in wheat, oats, barley, chickpea, lentil, field pea, rajma, rapeseed mustard, sunflower, safflower. Study of range of variation for yield and yield components. Learning inter specific crosses in wheat and chickpea. Trait based screening for stress resistance. Learning on the Standard Evaluation System (SES) and descriptors. Use of software for database management and retrieval. Identification of annual and perennial species of fodder. Evaluation of fodder crops for yield crops and biotic stresses.

**GPB-513 Breeding Vegetable Crops** **2+1** **Sem. I**

**( In collaboration with department of Vegetable Science)**

**Unit I** Important breeding methodologies for vegetable improvement. Integrating molecular markers in vegetable breeding programmes.

**Unit II** Breeding for Leafy vegetables: amaranth, chenopods and lettuce.

**Unit III** Breeding for Cucurbits: Gourds, melons, pumpkins and squashes.

**Unit IV** Breeding for Solanaceae: Potato and tomato, eggplant, hot pepper, sweet pepper.

**Unit V** Breeding for Cole Crops: cabbage, cauliflower, broccoli and knolkhol. Breeding for Root vegetables: carrot, beetroot, radish, sweet potato and tapioca.

**Unit VI** Breeding for other vegetable crops: Peas, beans, onion, garlic and okra.

**Practical :** Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm. Hybridization and handling segregating generations. Induction of flowering, palanological studies, selfing and crossing techniques in vegetable crops. Hybrid seed production of vegetable crops in bulk. Screening techniques for insect-pests, disease and environmental stress resistance in vegetable crops. Demonstration of sib-mating and mixed population. Molecular marker techniques to identify useful traits in the vegetable crops and specialbreeding techniques. Visit to breeding blocks, MAS for incorporating traits governed by major and polygenes.

**GPB-514 Breeding Fruit Crops** **2+1** **Sem. II**

**( In collaboration with department of Fruit Science)**

**Unit I** Fruit crop breeding: History, importance of fruit breeding, centers of diversity, distribution, domestication and adaptation of commercially important fruits.

**Unit II** Issues in fruit crop breeding – heterozygosity, polyploidy, polyembryony, parthenocarpy and seed lessness, incompatibility & sterility systems.

**Unit III** Apomixis - merits & demerits, types, variability for economic traits, role of genetic engineering and biotechnology in improvement of fruit crops.

**Unit IV** Crop improvement in Mango, Banana, Citrus, Grapes, Papaya, Sapota and Pomegranate, Pine apple & Guava, Apple and other Rosaceous crops and region-specific fruit crops.

**Practical :** Germplasm documentation; Floral biology of mango, guava, citrus, grape, pomegranate, pollen viability in major fruit crops. Pollen germination to study time of anthesis and stigma receptivity. Hybridization technique in important fruit crops, hybrid seed collection and raising. Colchicine treatment for induction of polyploidy. Exposure to resistance breeding & screening techniques. Mutation breeding

practices raising and evaluation of segregating populations. Use of mutagens to induce mutations and polyploidy. Visit to Biotechnology Lab & study of in– vitro breeding techniques.

**GPB-515 Breeding Ornamental Crop** **2+1** **Sem. I**

**( In collaboration with department of Landscape and Floriculture)**

**Unit I** History of improvement of ornamental plants. Centre of origin of ornamental crop. Objectives and techniques in ornamental plant breeding.

**Unit II** Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops viz., rose, jasmine, chrysanthemum, tuberose, gerbera, gladiolus, dahlia, lilium, gaillardia, petunia, bouganvillea, pansy, marigold, geranium, antirrhinum, china aster, orchids, antirrinum, carnation, hibiscus etc.

**Unit III** Development of promising cultivars of important ornamental and flower crops. Role of Heterosis and its exploitation, production of F1 hybrids and utilization of male sterility.

**Unit IV** Production of open pollinated seeds, harvesting, processing and storage of seeds; Seed certification.

**Practical :** Study of floral biology and pollination in important species and cultivars of ornamental crops. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seed. Methods of breeding suited to seed propagated plants. Polyploidy and mutations to evolve new varieties. Breeding methods for biotic and abiotic stresses. Visit to research institutes involved in ornamental crop breeding.

**GPB-516 Breeding for Stress Resistance and Climate Change** **2+1** **Sem. II**

**Unit I** Concept and impact of climatic change. Importance of plant breeding with special reference to biotic and abiotic stress resistance. Classification of biotic stresses- major pests and diseases of economically important crops.

**Unit II** Concepts of resistance to insect and pathogen resistance. Analysis and inheritance of resistance variation. Host defense responses to pathogen invasions- Biochemical and molecular mechanisms. Acquired and induced immunity and systemic acquired resistance (SAR). Host-pathogen interaction: gene-for-gene hypothesis, molecular evidence for its operation and exceptions. Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

**Unit III** Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. Quantitative resistance/adult plant resistance and slow rusting resistance. Classical and molecular breeding methods- Measuring plant resistance using plant fitness. Behavioural, physiological and insect gain studies. Phenotypic screening methods for major pests and diseases. Recording of observations. Correlating the observations using marker data. Gene pyramiding methods and their implications. Classification of abiotic stresses- Stress inducing factors, moisture stress/drought and water logging & submergence, acidity, salinity/alkalinity/sodicity, high/low temperature, wind, etc. Stress due to soil factors and mineral toxicity. Physiological and Phenological responses. Emphasis of abiotic stresses in developing breeding methodologies.

**Unit IV** Genetics of abiotic stress resistance. Genes and genomics in breeding cultivars suitable to low water regimes, water logging & submergence, high and low/freezing temperatures. Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc.Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

**Unit V** Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops.Transgenics in management of biotic and abiotic stresses. Use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management.

**Practical :** Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them for diseases caused by fungi and bacteria. Symptoms caused by major diseases and insect pests in major field crops and data recording. Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level. Phenotypic screening techniques for nematodes and borers. Ways of combating them. MAS for developing crop plants resistant

to diseases and pests. Ecological, environmental impacts of weeds on the crop cultivation and breeding for herbicide resistance. Evaluation of crop germplasm for heat tolerance, factors to be considered and breeding strategies. Screening crops for drought and flood tolerance; factors to be considered and breeding strategies. Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies. Screening forage crops for resistance to sewage water and tannery effluents. Effect on crop quality parameters in response to biotic and abiotic stresses and climate changes.

**GPB-517 Germplasm Characterization and Evaluation** **1+1** **Sem. I**

**Unit I** Understanding genetic diversity in crop plants. Crop descriptors and descriptor states. Germplasm characterization/ evaluation procedures for specific traits. Measuring diversity using agro-morphological data and statistical procedures to measure population genetic variation. Markers and their use in PGR. Evaluation of crop germplasm for biotic and abiotic stresses. Principles and methods for formulating core and mini core collections and their validation. Web based tools for management of data.

**Unit II** Principles and practices of germplasm regeneration and maintenance: breeding systems and mode of reproduction, maintaining sufficiently large populations for effective conservation of farmer landraces, evaluation and maintenance of wild relatives of crop plants, genetic enhancement. Use of CWRs genetic resources for crop improvement.

**Unit III** High throughput phenotyping systems- imaging & image processing concepts for automated germplasm characterization Evaluation for nutritional traits, resistance traits: use of biochemical and molecular markers.

**Practical** : Acquaintance with major global plant germplasm repositories and collections. Identification of wild relatives of different crop plants and maintenance in field. Field layout and experimental designs. Recording field data on germplasm evaluation in different agri-horticultural crops. Biochemical and phyto-chemical evaluation of crop germplasm. Morphological data/molecular marker based diversity analysis, development of core and mini cores, viability equations, sampling strategies, data documentation, cataloguing. Post-harvest handling.

**GPB-518 Genetic enhancement for PGR Utilization** **1+1** **Sem. II**

**Unit I** Concept of gene pools. Potential of pre-breeding. Role of crop wild relatives, semi exotics: creating and managing variation. Basic concepts to set up a successful prebreeding programme.

**Unit II** Understanding crop adaptation. Handling and maintenance of CWRs: synchronization of flowering, overcoming impediments to flowering through photoperiodic adjustments, role of other barriers to flowering, role of amphidiploids, semi exotics and other unadapted germplasm. Identifying desirable traits in natural populations: screening for biotic and abiotic stress resistance and nutritionally important traits. Genetic analysis to understand the inheritance of novel traits.

**Unit III** Parental selection for pre breeding. Breeding methods for trait transfer. Moving the genes/ traits from unadapted to adapted. Wide hybridization: pre & post-zygotic barriers. Cytological studies, florescence microscopy, embryo rescue methods, pollen physiology and storage, pollen storage methods to facilitate wide hybridization. Incongruity and its management. Modern tools for incongruity management. Cytogenetical approaches for gene transfer such as alien addition and substitution. Segregating populations and their management in wide crosses. Purging the undesirable traits. Testing and improving the adaptability of wide cross derivatives.

**Practical :** Characterization of CWRs by visiting the fields, Screening methods for special traits-biotic and abiotic resistance, Screening for nutritional traits. Crossability studies in CWRs of cereals, legumes, oilseeds, vegetables. Assessment of pre and post-zygotic barriers in wide hybridization crosses. Pollen storage studies. Special requirements for growing CWRs, inducing flowering by manipulating day length, temperature, chemical spraying, etc.

**PGS- 503 Intellectual Property and its Management in Agriculture** **1+0** **Sem I/II**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties;

Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

**PGS- 505 Agricultural research, research ethics and rural development programmes 1+0 Sem I/II**

**Unit I** History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

**Unit II** Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards, and problems in research ethics.

**Unit III** Concept and connotations of rural development, rural development policies and strategies, Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group - Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Government Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

**GPB-591 Seminar 1+0**

**GPB-599 Master's Research 0+30**

**Ph.D. courses**

**GPB-601 Advances in Plant Breeding Systems 3+0 Sem. II**

**Unit I** Advances in reproductive biology of crops. Genes governing the whorls formation and various models proposed. Pollen pistil interaction: biochemical and molecular basis, environmental factors governing anthesis and bottlenecks for gene transfer.

**Unit II** Plant Breeding methodologies: Classic versus modern. Over view of Pre and Post Mendelian breeding methods in self and cross pollinated crops. Molecular and transgenic breeding approaches. Doubled haploid breeding, shuttle breeding, forward and reverse breeding, speed breeding, participatory plant breeding, breeding for organic situations.

**Unit III** Principles and procedures in the formation of a complex population. Genetic basis of population improvement in crop plants. Recurrent selection methods in self and cross pollinated crops and their modifications. Convergent selection, divergent selection. Recurrent selection, usefulness in hybrid breeding programs. Reciprocal recurrent selection. Selection in clonally propagated crops –Assumptions and realities.

**Unit IV** Choice of molecular markers for plant breeding efficiency, fingerprinting and genetic diversity assessment, application of MAS for selection of qualitative and quantitative traits. Gene pyramiding, accelerated backcrossing, marker-based utilization of exotic germplasm, introgression libraries.

**Unit V** Genetic resources: primary, secondary, tertiary and alien trans gene pool. Molecular and biochemical basis of self-incompatibility and male sterility, nucleocytoplasmic interactions with special reference to male sterility – genetic, biochemical and molecular bases.

**Unit VI** Genetic engineering technologies to create male sterility, prospects and problems, use of self-incompatibility and sterility in plant breeding – case studies. Fertility restoration in male sterile lines and restorer diversification programs. Conversion of agronomically ideal genotypes into malesterile: Concepts and breeding strategies. Case studies - Generating new cyto-nuclear interaction system for diversification

of male sterile. Stability of male sterile lines – Environmental influence onsterility, Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS. Influence on their expression, genetic studies. Photo and thermo sensitive genetic male sterility and its use in heterosis breeding. Temperature sensitive genetic male sterility and its use heterosis breeding. Apomixis and its use in heterosis breeding. Incongruity: Factors influencing incongruity Methods to overcome incongruity mechanisms.

**Unit VII** Breeding for climate change -Improving root systems, abiotic stress tolerance, water use efficiency, flooding and sub-mergence tolerance. Biotic stress tolerance. Nutrient use efficiency, nitrogen fixation and assimilation, greenhouse gases and carbon sequestration. Breeding for bio-fortification.

**GPB-602 Advances in Biometrical Genetics** **2+1** **Sem. I**

**Unit I** Continuous variation-evolutionary studies. Genetic principles of continuous variation, Qualitative and quantitative techniques-differences, population types, approaches. Various types of metrices, F2, Fα and mixed. Selection of parents: Simultaneous selection models. Use of Multiple regression analysis in selection of genotypes.

**Unit II** Components of mean- Additive effect, breeding value, coefficient of gene dispersion, dominance. Scaling test, expectation of mean of character in various types of families in coupling and dispersed phase. Epistasis- Specification, weighted and unweighted joint scaling test. Effect of linkage to generation mean, specification of mean to G x E interaction.

**Unit III** Component of variances-advantages, variances of different generations, balance sheet of variance. Estimation of parameters-weighted and unweighted, least square analysis. Random mating population. Experimental population-BIPs, NCD-I, II, III, Line X Tester, Triple test cross, Diallel analysis using Griffin and Hayman's approach. Combining ability analysis. Estimates of linkage and non- allelic interactions.

**Unit IV** G x E Interaction, stability and adaptability. Advanced models in stability analysis - Pattern analysis Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models. Merits and limitation of different stability analysis methods. Methods and steps to select the best model - Biplots and mapping genotypes.

**Unit V** Different types of markers. Biparental and Multi-parental mapping populations. Construction of saturated linkage maps. Strategies for QTL mapping - desired populations, statistical methods. Association Mapping-Assembling mapping panels, Estimation of Structure, Linkage disequilibrium and decay, Kinship analysis, Different statistical approaches. Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS. Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods. Genomic selection: training and breeding populations, statistical methods, case studies. Comparison of Genomic selection and MAS. Simultaneous MAS and genomic Selection.

**Practical :** Generation mean analysis: ABC scaling test and Joint scaling test- Analysis and interpretation; Estimation of variance of different filial generations and interpretations; Diallel analysis: Numerical, graphical and combining ability analysis; Triallel analysis; NC Designs: Triple test cross analysis, Stability analysis: Eberhart and Russel model; AMMI model - Principal Component Analysis model -Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes

Methods and steps to select the best model - Selection systems – Biplots and mapping genotypes; Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies; Use of advanced software in biometrical analysis.

**GPB-603 Molecular Cytogenetics for Crop Improvement** **2+0** **Sem. I**

**Unit I** Organization and structure of genome, Genome size, Organization of organellar genomes, Nuclear DNA organization, Nuclear and Cytoplasmic genome interactions and signal transduction. Inheritance and expression of organellar DNA. Variation in DNA content - C value paradox. Sequence complexity Introns and Exons, Repetitive sequences, Role of repetitive sequence.

**Unit II** Karyotyping– Chromosome banding and chromosome painting. Tracking introgressions using FISH, GISH, localization and mapping of genes/genomic segments.

**Unit III** Pre-breeding and applications of cytogenetical methods for crop improvement. Location and mapping of genes on chromosomes: deficiency method. Interchange genetic consequence, identification of chromosomes involved and gene location. Balanced lethal systems, their maintenance and utility. Multiple interchanges-use in producing inbreds, transfer of genes- linked marker methods. Duplication - production and use. Inversions and location of genes. B/A chromosome translocations and gene location.

**Unit IV** Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production. Monosomics methods of production, breeding behavior and location of genes. Intervarietal substitutions-allelic and non-allelic interactions. Telocentric method of mapping.

**Unit V** Cytogenomics: Concept, tools and techniques for crop improvement. Chromosome sorting: Isolation of specific chromosome for development of molecular maps and gene location.

**Unit VI** Role of polyploidy in crop evolution and breeding. Auto- and allopolyploids. Distant hybridization, barriers to interspecific and intergeneric hybridization. Behaviour of interspecific and intergeneric crosses.

**GPB-604 Plant Genetic Resources, Conservation and Utilization 2+0 Sem. II**

**Unit I** Concept of natural reserves and natural gene banks. In situ conservation of wild species in nature reserves: in situ conservation components, factors influencing conservation value, national plan for in situ conservation. In situ conservation of agrobiodiversity on-farm. Scientific basis of in situ conservation on-farm, building on farm conservation initiatives, implementation of on-farm conservation, management of in situ conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

**Unit II** Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma- frost conservation, guidelines for seed multiplication and exchange to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling, clonal repositories, genetic stability under long term storage condition.

**Unit III** In vitro storage, maintenance of in vitro culture under different conditions, in vitro bank maintenance for temperate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of in vitro gene bank.

**Unit IV** Cryopreservation- procedure for handling seeds of orthodox and recalcitrant- cryoprotectants, desiccation, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agricultural, horticultural and forestry crops. Problems and prospects. Challenges ahead.

**Unit V** Concept and procedure for PGR management, germplasm characterization, evaluation and utilization. Concept of core and mini core. Collections and registration of plant germplasm.

**GPB-605 Genomics in Plant Breeding 2+1 Sem. II**

**Unit I** Introduction to the plant genomes: nuclear, chloroplast and mitochondrial genomes. Concept of genome size and complexity: C-value paradox, repetitive and unique DNA

**Unit II** Genome sequencing: Principles and techniques of conventional approaches and next generation sequencing including sequencing-by-synthesis/ligation and single molecule real time (SMRT) technologies. Applications of sequence information: structural, functional and comparative genomics. Plant genome projects: Strategies for genome sequencing including shot gun and clone-by-clone method.

**Unit III** Molecular maps: Use of molecular markers/SNPs for development of genetic and physical maps. Linkage and LD-based gene mapping approaches including gene/QTL mapping, genome wide association studies (GWAS) and association analysis. Integration of genetic and physical map for map-based cloning of economically important genes. Concept of allele mining. Diversity array technology: concepts and applications.

**Unit IV** Functional genomics: concept of reverse and forward genetics. Use of activation tagging, transposon tagging, insertional mutagenesis, TILLING and ecoTILLING for crop improvement. Genome-wide and gene-specific transcriptomics approaches: serial analysis of gene expression, massively parallel signature sequencing, next generation sequencing, microarray, northern hybridization, RT- PCR, qRT-PCR and molecular beacon.

**Unit V** Development and management of database. Applications of bioinformatics tools/software in genomics for crop improvement. Basic concepts of high-throughput proteomics, metabolomics and phenomics.

**Unit VI** Recent transgene free genome editing tools such as CRISPR-Cas9 system, TALENS and ZFNs for crop improvement. Cisgenesis and Intragenesis tools as twin sisters for Crop Improvement; Genomics- assisted plant breeding:

**Practical :** Plant genome databases. Next generation sequencer based high throughput genotyping data analysis. Identification and visualization of SNPs and InDels and development of markers. Construction of high-density linkage maps in R. Mapping genes/QTLs using BSA-seq, Bipraental mapping and GWAS. Designing single-guide RNA. Development of construct for CRISPR/Cas9 based genome editing. Protein modelling and functional genomics.

**GPB-606 Population Genetics** **2+0 Sem. II**

**Unit I** Population: Properties of population, Mendelian population. Genetic constitution of a population through time, space, age structure etc. Frequencies of genes and genotypes. Causes of change: population size, differences in fertility and viability, migration and mutation.

**Unit II** Hardy-Weinberg equilibrium, Hardy-Weinberg law, Proof and applications of the Hardy-Weinberg law, Test of Hardy-Weinberg equilibrium. Mating frequencies: Nondominance, Codominance, Snyder's ratio, importance and its effect over random mating in succeeding generations.

**Unit III** Multiple alleles, More than one locus, Sex linked genes. Use of gene and genotypic frequencies evaluation in field population level. Interpretations - Changes of gene frequency, Migration, Mutation, Recurrent and non-recurrent Selection. Balance between selection and mutation. Selection favoring heterozygotes. Overdominance for fitness.

**Unit IV** Mating systems, Random mating population, Nonrandom mating: selfing –inbreeding coefficient, panmictic index, sibmating, Assortative mating and disassortative mating. Pedigree populations and close inbreeding, Estimation of linkage disequilibrium, Correlation between relatives and estimation of F. Effect of inbreeding and sibbing in cross pollinated crops; Gene substitution and average effects. Breeding value- Genetic drift. Genetic slippage, Co-adapted gene complexes. Homoeostasis-Adaptive organization of gene pools. Polymorphism- Balanced and Non-balanced polymorphism, heterozygous advantage-Survival of recessive and deleterious alleles in populations.

**GPB-607 Crop Evolution** **3+0 Sem. I**

**Unit I** Origin and evolution of species. Centres of diversity/origin, diffused centres. Time and place of domestication. Patterns of evolution and domestication-examples and Case studies. Domestication and uniformity – Characteristics of early domestication and changes – Concept of gene pools and crop evolution. Selection and Genetic drift - Consequences.

**Unit II** Speciation and domestication–The process of speciation, Reproductive isolation barriers. Genetic differentiation during speciation. Hybridization - speciation and extinction. Exploitation of natural variation: Early attempts to increase variation, Distant hybridization and introgression, Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations. Gene transfer into cultivated species, tools and techniques. Validation of transferred genes and their expression. Controlled introgressions.

**Unit III** Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization. Genome organization – Transgenesis in crop evolution, Multifactorial genome, Intragenomic interaction, Intergenomic interaction, Genome introgression. Methods to study crop evolution- Contemporary Methods, Based on morphological features, Cytogenetic analysis, Allozyme variations and crop evolution, DNA markers, genome analysis and comparative genomics.

**Unit IV** Evolutionary significance of polyploidy, evolution of crop plants through ploidy manipulations. Polyploids: methods, use of autopolyploids. Haploidy and DH-method of production and use, allopolyploids. Synthesis of new crops. Case studies – Cereals, Pulses, Oilseeds, vegetables, Fibre crops, Plantation crops, Forage crops, Tuber crops, Medicinal Plants.

**GPB-608 Breeding Designer Crops** **1+1** **Sem. I**

**Unit I** Breeding of crop ideotypes. Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds-proteins, vaccines, gums, starch and fats.

**Unit II** Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode. Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement. Breeding for special traits viz., oil, protein, vitamins, amino acids etc. Ecospecific ideotypes, Ideotypes for high and low moisture conditions, low and high input conditions, conversion mechanism of C3 to C4 plants. Determination of genetics of above mentioned traits.

**Unit III** Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.

**Unit IV** Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming.

**Unit V** Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management.

**Practical :** Demonstration of plant responses to stresses through recent techniques. Water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/drought/salt shock proteins.

**GPB-609 IPR and Regulatory Mechanism** **1+0** **Sem. II**

Historical perspectives and need for the introduction of Intellectual Property Right regime. TRIPs and various provisions in TRIPS Agreement. Intellectual Property and Intellectual Property Rights (IPR). Benefits of securing IPRs. Indian Legislations for the protection of various types of Intellectual Properties. Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection. Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection. National Biodiversity protection initiatives. Convention on Biological Diversity. International Treaty on Plant Genetic Resources for Food and Agriculture. Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

**GPB-610/MBB-610 Genome Editing in plants** **2+0** **Sem. I**

Changing phase of plant breeding: from classical to targeted breeding. Molecular basis of recombination and DNA repair. Restriction enzymes: types and its importance. Early history of specific gene modifications. Origin of targeted breeding: Zinc finger and ZFN, TALEs and TALENs, use in targeted modifications. Discovery of CRISPR/Cas as a defense tool in bacteria. Types of CRISPR/ Cas system in bacteria. Designing CRISPR/Cas9 system for targeted breeding. Advances in CRISPR/ Cas system for targeted genetic changes: nickases, Cas12a, Cas12b, Base editors, prime editors.

**Practical :** Considerations in genome editing: target identification, designing gRNA, construct design, stage selection, construct delivery methods, mutant identification strategies. Multiplex genome editing. Transgene free methods in genome editing. CRISPR-ACT: CRISPR mediated gene activation and

deactivation. Epigenome editing and its potentials. Recent advances in genome editing. Applications of genome editing. Biosafety and regulatory considerations. Important case studies. Potential of gene editing for nutritional security, natural resource conservation and climate resilience.

**GPB-691 Seminar I** **1+0**

**GPB-692 Seminar II** **1+0**

**GPB-699 Ph.D. Research** **0+75**

# PLANT PATHOLOGY

## PROGRAMMES

**M.Sc. Plant Pathology**
**Ph.D. Plant Pathology**

## COURSE REQUIREMENTS

### M. Sc.

| | |
|---|---|
| Field of Specialization | Fungal Pathology, Plant Bacteriology, Plant Virology |
| Core Courses | Pl. Path.-501, Pl. Path.-502, Pl. Path.-503, Pl. Path.-504, Pl. Path-505, Pl. Path.-506 and Pl. Path.-515/ Pl. Path.-516/ Pl. Path.-517/ Pl. Path.-518 (as per field of specialization of student) |
| Minor Fields | Agrometeorology, Agronomy, Biochemistry, Entomology, Fruit Science, Floriculture & Landscaping, Nematology, Molecular Biology and Biotechnology, Genetics and Plant Breeding, Soil Science, Vegetable Science or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Stat.-502, and courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problems |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504. PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Fungal Pathology, Plant Bacteriology, Plant Virology Core Course Pl. Path.-604 |
| Minor Fields | Agrometeorology, Agronomy, Biochemistry, Entomology, Fruit Science, Floriculture & Landscaping, Nematology, Molecular Biology and Biotechnology, Genetics and Plant Breeding, Soil Science, Vegetable Science or any other as approved by the Dean, Postgraduate Studies |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problems |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Courses

**Pl. Path. 51 Diseases of Field Crops** **1+1** **Sem. I**

Importance and concept of plant diseases. Symptoms and causes of diseases. Study of important diseases of wheat, rice, maize, barley, cotton, sugarcane, sorghum, gram, moong, mash, red gram, rapeseed and mustard and groundnut. Economic aspects of disease control.

**Practical:** Diagnosis by studying symptoms of important diseases of field crops. Demonstration of important methods of plant disease management. Practical field training in the use and operation of plant protection equipments.

**Pl. Path. 52 Diseases of Fruit and Vegetable Crops** **1+1** **Sem. II**

Symptomatology, etiology and management of diseases of citrus, guava, mango, peach, pear, plum, ber, papaya, grapes, potato, tomato, brinjal, chillies, okra, cabbage, cauliflower, carrot, radish, turnip, onion, garlic and cucurbitaceous vegetables.

**Practical:** Diagnosis by studying symptoms of important diseases of fruit and vegetable crops. Preparation of fungicidal formulations.

## Undergraduate Courses

**Pl. Path.102 Fundamentals of Plant Pathology** **3+1** **Sem. II**

Plant Pathology-concepts, terms, scope, objectives, causes and importance of plant diseases. History of plant pathology with special reference to Indian work. Pathogenesis, disease triangle, tetrahedron. Classification of plant diseases. Plant pathogens- fungi, bacteria, fastidious vascular bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites with examples of diseases caused by them. Symptoms due to diseases and abiotic stresses. Fungi- definition, characters, somatic structures, type of thalli, fungal tissues, modifications of thallus, reproduction. Nomenclature- bionomial system and rules. Classification of fungi- key to divisions, sub-divisions, orders and classes. Bacteria and molliutes- morphological characters, methods of classification and reproduction. Viruses- nature, structure, replication and transmission. Phanerogamic plant parasites. Nematodes- morphology, reproduction, classification, symptoms and nature of damage. Growth and reproduction of plant pathogens. Liberation/ dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Role of enzymes/toxins and growth regulators in disease development. Defence mechanisms in plants. Epidemiology and factors affecting disease development. Principles and methods of plant disease management. Fungicides/antibiotics- formulations, classification, mode of action, resistance development and management.

**Practical:** Acquaintance with laboratory equipment. Microscopy. Collection and preservation of plant disease specimens. Preparation of culture media, isolation and Koch's postulates. Structures of fungi. Symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes for soil and plant material. Preparation of nematode mounting. Fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentration.

**Pl. Path. 104 Introductory Plant Pathology** **2+1** **Sem.II**

**[For students of B.Sc. (Hons.) Hort.]**

Plant Pathology-concepts, terms, scope, objectives. Causes and importance of plant diseases. History of plant pathology with special reference to Indian work. Plant Pathogenesis and disease triangle. Classification, characters and reproduction of fungi, bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites with examples of diseases caused by

them. Symptoms due to diseases and abiotic stresses. Dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Role of enzymes/toxins and growth regulators in disease development. Defense mechanisms in plants. Epidemiology and factors affecting disease development. Principles and methods of plant disease management. Fungicides/ antibiotics - formulations and classification.

**Practical:** Acquaintance with laboratory equipments. Microscopy. Collection and Preservation of plant disease specimens. Preparation of culture media, isolation and Koch's postulates. Structures of fungi. Symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes for soil and plant material. Preparation of nematode mounting. Fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentration.

**Pl. Path. 106 Introduction to Plant Pathology 1+1 Sem.II**

**[For students of B.Sc. (Hons.) Agri. Business]**

Definition, objectives, significance of plant pathology and economic losses. History of Plant Pathology. Types of plant diseases based on etiology, parts affected, geographical distribution, crops infected, sources of inoculum and symptoms. Introduction to fungi, bacteria, fastidious vascular bacteria, viruses, viroids, phytoplasmas, sprioplasmas, nematodes, phanerogamic parasites and abiotic causes of plant diseases. Epidemiology, elements of an epidemic, factors affecting the development of epidemic. Principles of plant disease management. Physical methods, biological methods, chemical methods, ISR/SAR and IDM approaches for disease management. Fungicide industry in India and world. Some important examples of plant diseases of agro-industrial importance and their management viz. rusts and smuts of wheat, blast of rice, red rot of sugarcane, angular leaf spot and leaf curl of cotton, damping off and root knot nematode disease of vegetables, early and late blight of potato & tomato, ripe fruit rot and anthracnose of chilies, foot rot and canker of citrus, anthracnose of guava, scab of apple.

**Practical:** Study of compound microscope. Collection and preservation of diseased specimens. Study of symptoms and diagnosis of economically important plant diseases. Identification of important plant pathogens. Preparation of culture media. Methods of sterilization and disinfection. Isolation techniques. Study of plant disease controlling chemicals and their commercial formulations. Calculation of spray concentration. Methods of pesticide application and their safe use. Visit to pesticide testing laboratory.

**Pl. Path. 301 Diseases of Field and Horticultural Crops & their Management –I 2+1 Sem. I**

Symptoms, etiology, disease cycle and management of diseases of following Crops:

i). Field Crops: Rice - blast, brown spot, bacterial blight, sheath blight, false smut, foot rot, khaira, tungro; Maize - stalk rots, downy mildews, leaf spots; Sorghum - smuts, grain mold, anthracnose; Bajra - downy mildew, ergot; Cotton - anthracnose, vascular wilt, black arm, leaf curl; Groundnut - early and late leaf spots, wilt, collar rot, peanut bud necrosis; Soybean - Rhizoctonia blight, bacterial spot, seed and seedling rot, mosaic; Pigeonpea - Phytophthora blight, wilt, sterility mosaic; Finger millet – blast, leaf spot; Black gram and green gram - Cercospora leaf spot, anthracnose, web blight, yellow mosaic; Castor - Phytophthora blight; Tobacco - black shank, black root rot, mosaic.

ii) Horticultural Crops: Guava - wilt, anthracnose; Banana - Panama wilt, bacterial wilt, Sigatoka, bunchy top; Papaya - foot rot, leaf curl, mosaic; Pomegranate - bacterial blight; Brinjal - Phomopsis blight and fruit rot, Sclerotinia blight, little leaf, root knot nematode; Tomato - damping off, wilt, early and late blight, buck eye rot, leaf curl, mosaic; Okra - yellow vein mosaic; Beans - anthracnose, bacterial blight; Ginger - soft rot; Turmeric - leaf spots; Colocasia - Phytophthora blight; Coconut - wilt, bud rot; Tea - blister blight; Coffee - rust.

**Practical:** General symptoms of plant diseases. Identification of symptoms and pathogens of selected diseases of rice, maize, sorghum, bajra, finger millet, cotton, groundnut, soybean, pigeonpea, black gram, green gram, castor, tobacco, guava, banana, papaya, pomegranate, brinjal, tomato, okra, ginger,

turmeric, colocasia, coconut, coffee and tea. Field visits for the diagnosis of field problems.Collection and preservation of plant diseased specimens for herbarium.

**Pl. Path. 302 Diseases of Field and Horticultural Crops & their Management – II 2+1 Sem. II**

Symptoms, etiology, disease cycle and management of diseases of following Crops:

Field Crops: Wheat - rusts, smuts, bunts, powdery mildew, Alternaria blight, ear cockle; Barley –smuts, stripe disease; Sugarcane - red rot, smut, wilt, grassy shoot, ratoon stunting, Pokkah boeng; Sunflower - Sclerotinia stem rot,Alternaria blight; Mustard - Alternaria blight, white rust, downy mildew, Sclerotinia stem rot; Gram - wilt, grey mould, Ascochyta blight;Lentil – rust, wilt;Pea - downymildew, powdery mildew, rust; Berseem- stem rot.

Horticultural Crops: Mango - anthracnose, malformation, bacterial blight, powdery mildew, blacktip; Citrus-gummosis, scab, die back, canker, greening; Grape vine - downy mildew, powdery mildew, anthracnose; Apple - scab, powdery mildew, fire blight; Peach - leaf curl, crown gall;Strawberry - leafspot; Potato - early & late blight, black scurf, common scab, leaf roll, mosaic; Cruciferous vegetables- Alternaria leaf spot, black rot; Cucurbits - downy mildew, powdery mildew, wilt, mosaic; Onion and garlic - purple blotch, Stemphylium blight, downy mildew; Chillies -anthracnose and fruit rot, wilt, leaf curl; Coriander - stem gall; Marigold- Botrytis blight; Rose - dieback, powdery mildew, black leafspot; Gladiolus - Botrytis blight.

**Practical:** Identification of symptoms and pathogens of selected diseases of wheat, barley, sugarcane, sunflower, mustard, gram, lentil, peas, berseem, mango, citrus, grapevine, apple, peach, strawberry, potato, cruciferous vegetables, cucurbits, onion, garlic, chilli, coriander, marigold, rose and gladiolus. Field visits for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

**Pl. Path. 303 Management of Post-harvest and Seed-borne Diseases 1+1 Sem.I**

**[For students of B.Sc. (Hons.) Agri. Business]**

Economic significance of post-harvest and seed -borne diseases. Historical development in post- harvest and seed pathology. Objectives of post-harvest and seed pathology. Seed processing, treatment and storage. Seed transmission, seed contamination, accompanying pathogens, false seed transmission. Processing, seed treatment, seed packaging, packaging materials. Functional requirement of packing materials. Epidemiology and factors affecting disease development. Study of important post-harvest and seed-borne diseases (transport, storage & market) of vegetables, fruits, oilseeds etc. Management strategies for post harvest and seed borne diseases. Biotechnological approaches of disease management. IPR and related issues. IDM modules for important post- harvest and seed - borne diseases. Storage/field fungi responsible for production of toxins and their effects on consumption. Mycotoxins in seed and post harvest produce.

**Practical:** Study of post-harvest disease symptoms caused by fungi, bacteria, virus, nematodes etc., Methods of diagnosis of various post-harvest diseases. Methods of estimation of disease severity and losses. Seed health testing techniques. Methods of detection and identification of seed-borne pathogens. Bio-control agents, their efficacy and application for management of post harvest and seed-borne diseases. Study of fungicides, bactericides, nematicides and their formulations. Bioassay of fungicides. Seed treatment techniques for the control of seed-borne diseases. Study of seed packaging & storage techniques. Visit to vegetable and fruit markets, bio-pesticide/ pesticide firms.Visit to processing warehouse and testing laboratories.

**Pl. Path. 304 Diseases of Horticultural Crops & their Management 3+1 Sem. II**

**[For students of B.Sc. (Hons.) Hort.]**

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases under protected conditions and of fruits, plantation, medicinal, aromatic, vegetables, ornamental, and spice crops viz –mango, litchi, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine, senna, neem, hemp, belladonna,

pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum*, Tephrosia, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon. Jasmine, rose, crossandra, tuberose, gerbera, anthurium, geranium, marigold, gladiolus. Important post-harvest diseases of fruit, plantation, medicinal, aromatic, vegetables, ornamental and spice crops and their management. Etiology, symptoms and integrated management of important plant parasitic nematodes of fruits (tropical, sub-tropical and temperate), vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex.

**Practical:** Observations of disease symptoms, identification of causal organisms and host parasite relationship of important diseases of fruits, plantation, medicinal, aromatic, vegetables, ornamental and spice crops. Collection and preservation of diseased plant specimen.

**Ent.-Pl. Path.202 Principles of Integrated Pest and Disease Management 2+1 Sem. II**

Categories of insect pests and diseases. IPM - Introduction, history, importance, concepts, principles and tools. Economic importance of insect pests, diseases and pest risk analysis. Methods of detection and diagnosis of insect pests and diseases.Importance, calculation and dynamics of EIL and ETL. Methods of pest control - host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Recent technologies for pest management. Pesticides and their misuse; first aid and antidotes. Insecticides Act 1968. Spray technology. Ecological management of crop environment. Survey, surveillance and forecasting of insect pests and diseases. Development and validation of IPM module. Implementation and impact of IPM. IPM modules for insect pests and diseases. Safety issues in pesticide uses. Political, social and legal implications of IPM. Case histories of important IPM programmes.

**Practical:** Methods of diagnosis and detection of various insect pests and plant diseases. Sampling techniques for estimation of insect-pest and disease indices. Measurement of incidence of insect pests and diseases. Assessment of crop yield losses. Working out economics of IPM. Identification of biocontrol agents and natural enemies. Mass multiplication of *Beauveria bassiana, Bacillus thuringiensis, Trichoderma, Pseudomonas*, NPV and various parasitoids and predators. Pesticide appliances and their maintenance. Calculation of pesticide quantity for preparing spray material. Plan and assess preventive strategies (IPM module) and decision making. Monitoring of crop attacked by insect pests and diseases. Awareness campaign at farmers' fields.

**Ent.-Pl. Path. 203 Fundamentals of Crop Protection 2+1 Sem. I**

**[For students of B. Tech. (Biotechnology)]**

Insects - their general body structure and modifications. Importance of insects in agriculture. Insect metamorphosis and development stages. Insect diversity. Feeding stages of insects and kinds (modifications) of mouth parts. Concepts in population build-up of insects - GEP, DB, EIL, ETH and pest status. Categories of insect-pests. Causes of insect-pests outbreak. General symptoms of insects attack. Principles and methods of insect-pests management. Integrated Pest Management concept. Bioecology and management of important pests of major crops and storage products. Importance and scope of plant pathology. Concept of disease in plants. Nature and classification of plant diseases. Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites. Pathogenesis due to obligate and facultative parasites. Variability in plant pathogens. Conditions necessary for development of disease epidemics. Survival and dispersal of plant pathogens. Management of key diseases and nematodes of major crops.

**Practical:** Familiarization with generalized insect's body structure and appendages. Life stages. Acquaintance with insect diversity. Identification of important insect-pests of cereals, cotton, oilseeds, pulses, sugarcane,fruit and vegetables crops and stored-grains, and their symptoms of damage. Acquaintance with useful insects: predators, parasitoids, pollinators, honey bees and silk worms. Acquaintance to plant pathology laboratory equipment. Preparation of culture media for fungi and bacteria. Demonstrationof Koch's postulates. Study of different groups of fungicides and antibiotics and methods of their evaluation. Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and their characteristic symptoms. Acquaintance with various pesticidal formulations. Principles and working of common plant protection appliances. Calculation for preparing spray material.

**Ent.-Pl.Path. 491 Agro-Industrial Attachment** **0+4** **Sem. I**

Pesticide and Biopesticide Industries, Biocontrol Agents Production Units, Plant Quarantine Station, Virus free Potato Tuber Production Units.

**Ent.-Pl.Path.492: Experiential Learning in Production Technology for Bioagents** **0+20** **Sem. II**

## Postgraduate Courses

**Pl. Path.-501 Mycology** **2+1** **Sem. I**

**Unit I** Introduction, definition of different terms, basic concepts. Importance of mycology in agriculture, relation of fungi to human affairs. History of mycology. Importance of culture collection and herbarium of fungi. Somatic characters and reproduction in fungi. Modern concept of nomenclature and classification, Classification of kingdom fungi, Stramenopila and Protists.

**Unit II** The general characteristics of protists and life cycle in the Phyla Plasmodio-phoromycota, Dictyosteliomycota, Acrasiomycota and Myxomycota. Kingdom Stramenopila: characters and life cycles of respective genera under Hypochytriomycota, Oomycota and Labyrinthulomycota.

**Unit III** Kingdom fungi: General characters, ultrastructure and life cycle patterns in representative genera under Chytridiomycota, Zygomycota, Ascomycota; Archiascomycetes, Ascomycetous yeasts, Pyrenomycetes, Plectomycetes, Discomycetes, Loculoascomycetes, Erysiphales and anamorphs of ascomycetous fungi.

**Unit IV** Basidiomycota: General characters, mode of reproduction, types of basidiocarps and economic importance of Hymenomycetes. Uridinales and Ustilaginales; variability, host specificity and life cycle pattern in rusts and smuts. Mitosporic fungi; status of asexual fungi, their teleomorphic relationships, Molecular characterization of plant pathogenic fungi.

**Practical :** Detailed comparative study of different groups of fungi; Collection of cultures and live specimens. Saccardoan classification and classification based on conidiogenesis. Vegetative structures and different types of fruiting bodies produced by slime molds, stramenopiles and true fungi. Myxomycotina: Fructification, plasmodiocarp, sporangia, plasmodium and aethalia. Oomycota; somatic and reproductory structures of Pythium, Phytophthora, downy mildews and Albugo, Zygomycetes: Sexual and asexual structures of Mucor, Rhizopus, General characters of VAM fungi. Ascomycetes; fruiting structures, Erysiphales, and Eurotiales; general identification characters of Pyrenomycetes, Discomycetes, Loculoascomycetes and Laboulbeniomycetes, Basidiomycetes; characters, ultrastructures and life cycle patterns in Ustilaginomycetes and Teliomycetes, Deuteromycetes; characters of Hyphomycetes and Coelomycetes and their teliomorphic and anamorphic states, Collection, preservation, culturing and identification of plant parasitic fungi. Application of molecular approaches and techniques for identification of fungal pathogens.

**Pl.Path.- 502 Plant Virology** **2+1** **Sem. I**

**Unit I** History and economic significances of plant viruses. General and morphological characters, composition and structure of viruses. Myco-viruses, arbo and baculo viruses, satellite viruses, satellite RNAs, phages, viroids and prions. Origin and evolution of viruses and their nomenclature and classification.

**Unit II** Genome organization, replication in selected groups of plant viruses and their movement in host. Response of the host to virus infection: biochemical, physiological, and symptomatical changes. Transmission of viruses and virus-vector relationship. Isolation and purification of viruses.

**Unit III** Detection and identification of plant viruses by using protein and nucleic acid based diagnostic techniques. Natural (R-genes) and engineering resistance to plant viruses. Latest diagnostic tools.

**Unit IV** Virus epidemiology and ecology (spread of plant viruses in fields, host range and survival). Management of diseases caused by plant viruses.

**Practical :** Study of symptoms caused by plant viruses (followed by field visit). Isolation and biological purification of plant virus cultures. Bioassay of virus cultures on indicator plants and host differentials. Transmission of plant viruses (mechanical, graft, vector and study of disease development). Plant virus

purification (clarification, concentration, centrifugation, high resolution separation and analysis of virions), Electron microscopy for studying viral particle morphology. Antisera production. Detection and diagnosis of plant viruses with serological (ELISA), Lateral flow assay, RCA, nucleic acid non-PCR–LAMP, micro array & PCR based techniques. Exposure to basic bio-informatic tools for viral genome analysis and their utilization in developing detection protocols and population studies (BLASTn tool, Primer designing software, Bioedit tool, Claustal X/W, MEGA Software).

**Pl.Path.-503 Plant Pathogenic Prokaryotes** **2+1** **Sem. I**

**Unit I** Prokaryotic cell: History and development of plant bacteriology, history of plant bacteriology in India. Evolution of prokaryotic life, prokaryotic cytoskeletal proteins. Structure of bacterial cell. Structure and composition of Gram negative and Gram positive cell wall; synthesis of peptidoglycan; Surface proteins; Lipopolysaccaride structure; Membrane transport; Fimbrae and pili (Type IV pili); Mechanism of flagellar rotatory motor and locomotion, and bacterial movement; Glycocalyx (S-layer; capsule); the bacterial chromosomes and plasmids; Operon and other structures in cytoplasm; Morphological feature of fastidious bacteria, spiroplasmas and phytoplasmas.

**Unit II** Growth and nutritional requirements. Infection mechanism, role of virulence factors in expression of symptoms. Survival and dispersal of phytopathogenic prokaryotes.

**Unit III** Taxonomy of phytopathogenic prokarya: Taxonomic ranks hierarchy; Identification, classification and nomenclature of bacteria, phytoplasma and spiroplasma. The codes of nomenclature and characteristics. Biochemical and molecular characterization of phytopathogenic prokaryotes.

**Unit IV** Variability among phytopathogenic prokarya: General mechanism of variability (mutation); specialized mechanisms of variability (conjugation; transformation; transduction; transposition); and horizontal gene transfer.

**Unit V** Bacteriophages, L form of bacteria, plasmids and bdellovibrios: Structure; Infection of host cells; Phage multiplication cycle; Classification of phages, Use of phages in plant pathology/bacteriology, Lysogenic conversion; H Plasmids and their types, plasmid borne phenotypes. Introduction to bacteriocins. Strategies for management of diseases caused by phytopathogenic prokaryotes

**Practical** : Study of symptoms produced by phytopathogenic prokaryotes. Isolation, enumeration, purification, identification and host inoculation of phytopathogenic bacteria. Stains and staining methods. Biochemical and serological characterization. Isolation of genomic and plasmid DNA. Use of antibacterial chemicals/antibiotics. Isolation of fluorescent *Pseudomonas*. Preservation of bacterial cultures. Identification of prokaryotic organisms by using 16S rDNA, and other gene sequences. Diagnosis and management of important diseases caused by bacteria and mollicutes.

**Pl.Path.- 504 Plant Nematology** **2+1** **Sem. II**

**Unit I** Characteristics of Phylum Nematoda and its relationship with other related phyla, history and growth of Nematology; nematode habitats and diversity- plant, animal and human parasites; useful nematodes; economic importance of nematodes to agriculture, horticulture and forestry.

**Unit II** Gross morphology of plant parasitic nematodes; broad classification, nematode biology, physiology and ecology.

**Unit III** Types of parasitism; nature of damage and general symptomatology; interaction of plant-parasitic nematodes with other organisms.

**Unit IV** Plant nematode relationships, cellular responses to infection by important phytonematodes; physiological specialization among phytonematodes.

**Unit V** Principles and practices of nematode management; integrated nematode management.

**Unit VI** Emerging nematode problems, Importance of nematodes in international trade and quarantine..

**Practical :** Studies on kinds of nematodes- free-living, animal, insect and plant parasites; nematode extraction from soil; extraction of migratory endoparasites, staining for sedentary endoparasites; examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.

**Pl.Path. -505 Principles of Plant Pathology** **2+1** **Sem. I**

**Unit I** Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

**Unit II** Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

**Unit III** Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; phenolics, phytoalexins, PR proteins, elicitors. Altered plant metabolism as affected by plant pathogens.

**Unit IV** Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

**Practical :** Basic plant pathological techniques. Isolation, inoculation and purification of plant pathogens and proving Koch's postulates. Techniques to study variability in different plant pathogens. Purification of enzymes, toxins and their bioassay. Estimation of growth regulators, phenols, phytoalexins in resistant and susceptible plants.

**Pl. Path.- 506 Techniques for Detection and Diagnosis of Plant Diseases** **0+2** **Sem. I**

**Practical :** Detection of plant pathogens: Based on visual symptoms, biochemical test, using microscopic techniques, cultural studies; (use of selective media to isolate pathogens). biological assays (indicator hosts, differential hosts), serological assays, nucleic acid based techniques (Non-PCR– LAMP, Lateral flow assay, microarray & PCR based- multiplex, nested, qPCR, immuno capture PCR, etc.). Phenotypic and genotypic tests for identification of plant pathogens. Molecular identification (16S rDNA and 16s-23S rDNA intergenic spacer region sequences-prokaryotic organisms; and eukaryotic organism by ITS region) and whole genome sequencing. Volatile compounds profiling by using GC- MS and LC-MS. FAME analysis, Fluorescence in-situ Hybridization (FISH), Flow Cytometry, Phage display technique, biosensors for detection of plant pathogens. Genotypic tools such as genome/ specific gene sequence homology comparison by BLAST (NCBI and EMBL) and electron microscopy techniques of plant virus detection and diagnosis.

**Pl.Path.-507 Principles of Plant Disease Management** **2+1** **Sem. I**

**Unit I** Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management.

**Unit II** History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals. Label claim of fungicides.

**Unit III** Application of chemicals on foliage, seed and soil, role of stickers, spreaders and other adjuvants. Deleterious effects of chemical application and safety measures.

**Practical :** Phytopathometry. Methods of in vitro evaluation of chemicals, antibiotics, bio agents against plant pathogens. Field evaluation of chemicals, antibiotics, bio agents against plant pathogens. Soil solarisation, methods of soil fumigation under protected cultivation. Methods of application of chemicals and bio control agents. ED and MIC values, study of structural details of sprayers and dusters. Artificial epiphytotic and screening of resistance.

**Pl. Path.-508 Epidemiology and Forecasting of Plant Diseases** **1+0** **Sem. II**

**Unit I** Epidemic concepts, simple interest and compound interest disease, historical development. Elements of epidemics and their interaction. Structures and patterns of epidemics. Modelling, system approaches and expert systems in plant pathology.

**Unit II** Genetics of epidemics. Models for development of plant disease epidemics. Common and natural logarithms function fitting, area under disease progress curve and correction factors, inoculum dynamics. Population biology of pathogens, temporal and spatial variability in plant pathogens.

**Unit III** Epidemiological basis of disease management. Survey, surveillance and vigilance. Remote sensing techniques and image analysis. Crop loss assessment.

**Unit IV** Principles and pre-requisites of forecasting, systems and factors affecting various components of forecasting, some early forecasting and procedures based on weather and inoculum potential, modelling disease growth and disease prediction. Salient features of important forecasting models.

**Pl.Path.-509 Disease Resistance in Plants 2+0 Sem. II**

**Unit I** Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminologies. Diseaseescape, non-host resistance and disease tolerance.

**Unit II** Genetic basis of disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

**Unit III** Host defence system, morphological and anatomical resistance, pre-formed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms. Genetic basis of relationships between pathogen and host, Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

**Pl.Path.-510 Ecology of Soil Borne Plant Pathogens 1+1 Sem. I**

**Unit I** Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane,host exudates, soil and root inhabiting fungi. Interaction of microorganisms.

**Unit II** Types of biocontrol agents. Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis. Conducive and suppressive soils.

**Unit III** Biological control- concepts and potentialities for managing soil borne pathogens. Potential of biocontrol agents in managing plant diseases.

**Practical :** Quantification of rhizosphere and rhizoplane microflora with special emphasis on pathogens; pathogenicity test by soil and root inoculation techniques, correlation between inoculum density of test pathogens and disease incidence, demonstration of fungistasis in natural soils; suppression of test soil- borne pathogens by antagonistic microorganisms. Isolation and identification of different biocontrol agents. Study of various plant morphological structures associated with resistance, testing the effect of root exudates and extracts on spore germination and growth of plant pathogens. Estimating the phenolic substances, total reducing sugars in susceptible and resistant plants.Estimating the rhizosphere and root tissue population of microorganisms (pathogens) in plants.

**Pl.Path.-511 Chemicals and Botanicals in Plant Disease Management 2+1 Sem. II**

**Unit I** History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals and botanicals.

**Unit II** Classification of chemicals used in plant disease management and their characteristics.

**Unit III** Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals. Issues related to label claim.

**Unit IV** Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of fungicides.

**Unit V** Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides. New generation fungicides and composite formulations of pesticides.

**Unit VI** Efficacy of different botanicals used and their mode of action. Important botanicals used against diseases. General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.

**Practical :** Acquaintance with formulation of different fungicides and plant protection appliances. Formulation of fungicides, bactericides and nematicides; in vitro evaluation techniques, preparation of different concentrations of chemicals including botanical pesticides against pathogens; persistence,

compatibility with other agro-chemicals; detection of naturally occurring fungicide resistant mutants of pathogen; methods of application of chemicals.

**Pl.Path.-512 Detection and Management of Seed Borne Pathogens 2+1 Sem. II**

**Unit I** History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

**Unit II** Recent advances in detection of plant pathogens in seed and seedlings, their establishment and subsequent development. Localization and mechanisms of seed transmission in relation to seed infection and seed to plant transmission of pathogens.

**Unit III** Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed- borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

**Unit IV** Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogens/ diseases and procedure for healthy seed production. Seed health testing, methods for detecting microorganism.

**Practical :** Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses. Relationship between seed-borne infection and expression of the disease in the field. Seed health testing.

**Pl.Path.-513 Biological Control of Plant Pathogens 1+1 Sem. I**

**Unit I** Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

**Unit II** Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

**Unit III** Factors governing biological control, role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne, seed-borne and foliar diseases. Compatibility of bioagents with agrochemicals and other antagonistic microbes.

**Unit IV** Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming systems, biopesticides available in market. Quality controlsystem of biocontrol agents.

**Practical :** Isolation, characterization and maintenance of antagonists, methods to study the process of antagonism and antibiosis. Bioefficacy of antagonists against pathogens in vitro and in vivo conditions. Preparation of different formulations of selected bioagents and their mass production. Quality parameters of biocontrol agents. Exposure visit(s) to commercial biocontrol agents production unit(s).

**Pl.Path.-514 Integrated Disease Management 2+1 Sem. II**

**Unit I** Introduction, definitions, concept and tools of disease management, components of integrated disease management- their limitations and implications.

**Unit II** Integrated Disease Management (IDM)- basic principles, host resistance, biological, physical, chemical and cultural disease management.

**Unit III** IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed-mustard, pearl millet, pulses, vegetable crops, fruit, plantation and spice crops.

**Practical :** Application of physical, biological and cultural methods, Use of chemical and biocontrol agents, their compatibility and integration in IDM. Demonstration of IDM and multiple disease management in crops of regional importance as project work.

**Pl.Path.-515 Diseases of Field and Medicinal Crops 2+1 Sem. II**

Introduction, symptomatology, etiology, disease cycle, factors affecting disease development and management of following:

**Unit I** Diseases of Cereal crops- Rice, wheat, barley, pearl millet, sorghum and maize.

**Unit II** Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean and cowpea.

**Unit III** Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.

**Unit IV** Diseases of Cash crops- cotton, sugarcane.

**Unit V** Diseases of Fodder crops- berseem, oats, guar, lucerne.

**Unit VI** Medicinal crops- neem, plantago, liquorice, mulathi, rosagrass, sacred basil, mentha, ashwagandha, Aloe vera.

**Practical :** Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops.

**Pl.Path.-516 Diseases of Fruits, Plantation and Ornamental Crops 2+1 Sem. I**

Introduction, symptomatology, etiology, disease cycle, factors affecting disease development and management of following:

**Unit I** Diseases of fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond, strawberry, citrus,mango, grapes, guava, ber, banana, pineapple, papaya, litchi, fig, pomegranate, date palm custard apple.

**Unit II** Diseases of plantation crops such as tea, coffee, rubber and coconut.

**Unit III** Diseases of ornamental plants such as roses, gladiolus, tulip, carnation, gerbera, orchids, marigold,chrysanthemum and turf.

**Practical :** Detailed study of symptoms and host parasite relationship of representative diseases of plantation crops. Collection and dry preservation of diseased specimens of important crops.

**Pl.Path.-517 Diseases of Vegetable and Spices Crops 2+1 Sem. II**

Introduction, symptomatology, etiology, disease cycle, factors affecting disease development and management of following:

**Unit I** Diseases of tuber, bulb, leafy vegetable, crucifers, cucurbits and solanaceaous vegetables. Diseases of crops under protected cultivation.

**Unit II** Diseases of different spice crops such as black pepper, nutmeg, saffron, cumin, coriander, turmeric,fennel, fenugreek and ginger.

**Unit III** Biotechnological approaches in developing disease resistant transgenics.

**Practical :** Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops.

**Pl.Path.-518 Post Harvest Diseases 2+1 Sem. I**

**Unit I** Concept of post-harvest diseases, definitions, importance with reference to management and health, principles of plant disease management as pre- harvest and post-harvest, Types of post-harvest problems both by biotic and abiotic factors.

**Unit II** Role of physical environment, agro-ecosystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens; pathogens and antagonist and their relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases, approaches to control plant pathogens by resident and introduced antagonists.

**Unit III** Integrated approaches in controlling diseases and improving the shelf life of produce using nutritional, bio-control agents and other agents, control of aflatoxigenic and mycotoxigenic fungi and associated health hazards.

**Unit IV** Study of symptoms, toxicosis of various pathogens, knowledge of Codex Alimentarious for each product and commodity. Physical and biological agents/practices responsible for development/ prevention of post-harvest diseases- traditional and improved practices.

**Practical :** Isolation, characterization and maintenance of post- harvest pathogens, application of antagonists against pathogens in vitro and in vivo condition. Bioefficacy of different fungicides and bioagents. Study of different post-harvest disease symptoms on cereals, pulses, oilseed, commercial crops, vegetables, fruits and flowers. Visit to cold storage/ waxing units.

**Pl.Path.-519 Plant Quarantine and Regulations** **1+0** **Sem. I**

**Unit I** Historical developments in plant quarantine, Definitions of pest, and transgenics as per Govt. notification; Organizational set up of plant quarantine in India. Relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

**Unit II** Acts related to registration of pesticides and transgenics. History of quarantine legislations, Salientfeatures of PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

**Unit III** Identification of pest/disease free areas; contamination of food with toxins, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

**Unit IV** WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures. Visit to plant quarantine station and PEQ facilities.

**Pl.Path.-591 Seminar** **1+0**

**Pl. Path.-599 Master's Research** **0+30**

**Ph.D. courses**

**Pl. Path.-601 Advances in Mycology** **2+1** **Sem. I**

**Unit I** General introduction, historical development and advances in mycology. Recent taxonomic criteria, morphological criteria for classification. Serological, chemical (chemotaxonomy), molecular and numerical (computer based assessment) taxonomy. Interaction between groups: Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti.

**Unit II** Population biology, pathogenic variability/ vegetative compatibility. Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

**Unit III** Ultra structures and chemical constituents of fungal cells, functions of cell organelles. Mitosis, meiosis, gene action and regulation. Effect of fungal interaction with host plants and other microorganisms; parasitism, symbiosis and commensalism.

**Unit IV** Genetic improvement of fungal strains. Fungal biotechnology. Fungi mediated synthesis of nano particles - characterization process and application. Mycotoxins problems and its management.

**Practical :** Isolation, purification and identification of cultures, spores and mating type determination. Study of conidiogenesis-Phialides, porospores, arthospores. Study of fruiting bodies in Ascomycotina. Identification of fungi up to species level. Study of hyphal anastomosis. Morphology of representative plant pathogenic genera from different groups of fungi. Molecular characterization of fungi.

**Pl. Path.-602 Advances in Plant Virology** **2+1** **Sem. I**

**Unit I** Origin, evolution and interrelationship with animal viruses. Virus morphology, structure, architecture, replication, assembly and virus specific cytological effects in infected plant cells. Mechanisms leading to the evolution of new viruses/strains: mutation, recombination, pseudo-recombination, component reassortment etc.

**Unit II** Major vector groups of plant viruses and their taxonomy, virus-vector relationship, molecular mechanism of virus transmission by vectors. Terminologies used in immunology and serology. Classification, structure and functions of various domains of Immunoglobulins. Production of polyclonal and monoclonal antibodies for detection of viruses. Immuno/serological assays (Slide agglutination tests, Test tube precipitation test, Double agar diffusion test, ELISA (DAC, DAS, TAS), Dot Immuno Binding Assay, and nucleic acid based assays for detection of plant viruses.

**Unit III** Polymerase Chain Reaction based (PCR, reverse transcriptase PCR, multiplex PCR, Nested PCR, Real time/q PCR) and non PCR based (LAMP, Fluorescent in situ hybridization (FISH), dot blot hybridization). Plant virus genome organization (General properties of plant viral genome- information content, coding and non-coding regions), replication, transcription and translational strategies of pararetroviruses, geminiviruses, tobamo-, poty-, bromo, cucumo, ilar, tospoviruses, satellite viruses and satellite RNA.

**Unit IV** Gene expression, regulation and viral promoters. Genetic engineering with plant viruses, viral suppressors, RNAi dynamics and resistant genes. Virus as potential vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture for production of virus free planting materials. Phylogenetic grouping system based on partial/complete sequences of virus genomes and using of next generation sequencing technology in plant virus discovery.

**Practical :** Purification of viruses, SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation. Acquaintance with different serological techniques (i) DAC- ELISA (ii) DAS-ELISA (iii) TAS-ELISA (iv) DIBA (v) Western blots (vi) (ab) 2- ELISA. Nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradio-graphy. PCR application and viral genome cloning of PCR products, plasmid purification, enzyme digestion, sequencing, annotation of genes, analysis of viral sequences (use of Genbank, blast of viral sequences and phylogeny). Bioinformatics analysis tools for virology (ORF finder, Gene mark, Gene ontology, BLAST, Clustal X/W, Tm pred and Phylogeny programs).

**Pl. Path.-603 Advances in Plant Pathogenic Prokaryotes 2+1 Sem. II**

**Unit I** Prokaryotic cell: Molecular basis for origin and evolution of prokaryotic life, RNA world, prokaryotic cytoskeletal proteins. Flagella structure, assembly and regulation. Structure and composition (bacteria) cell wall/envelop, Types of secretion systems (TI to TIV) and their molecular interactions, fimbriae and pili (Type IV pili), Bacterial chromosome and plasmids, other cell organelles. Growth, nutrition and metabolism in prokaryotes (Embden Meyerhof pathway, Phosphoketolase Pathway and Entner Doudoroff Pathway).

**Unit II** Current trends in taxonomy and identification of phytopathogenic prokarya: International codeof nomenclature, Polyphasic approach, New / special detection methods for identification of bacterial plant pathogens. Taxonomic ranks hierarchy; Identification, Advances in classification and Nomenclature.

**Unit III** Bacterial genetics: General mechanism of variability (mutation), specialized mechanisms of variability. Transposable genetic elements in bacteria, integron and prophages, Mechanism of gene transfer. Pathogenicity islands, horizontal gene transfer, Bacterial Pan-Genome.

**Unit IV** Bacteriophages: Composition, structure and infection. Classification and use of phages in plant pathology/bacteriology. Host pathogen interactions: Molecular mechanism of pathogenesis: Pathogenicity factors of soft rot, necrosis, wilt, canker etc. Immunization, induced resistance/ Systemic Acquired Resistance, Quorum sensing. Bacterial pathogenicity and virulence: Molecular mechanism of virulence and pathogenesis, bacterial secretion systems, bacterial enzymes that degrade the cell walls, Role of *hrp/hrc* genes and TAL effectors. Synthesis and regulation of EPSs.

**Unit V** Beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role in disease management. Endosymbionts for host defence. Advances in management of diseases caused by prokaryotes: genetic engineering, RNA silencing; CRISPR Cas9.

**Practical :** Pathogenic studies and race identification, plasmid profiling of bacteria, fatty acid profiling of bacteria, RFLP profiling of bacteria and variability status, Endospore, Flagella staining, Test for secondary metabolite production, cyanides, EPS, siderophore, specific detection of phytopathogenic bacteria using

species/ pathovar specific primers. Basic techniques in diagnostic kit development, Molecular tools to identify phytoendosymbionts. Important and emerging diseases and theirmanagement strategies.

**Pl. Path.- 604 Molecular Basis of Host- Pathogen Interaction** **2+1** **Sem. II**

**Unit I** History of host plant resistance and importance to Agriculture. Importance and role of biotechnologicaltools in plant pathology. Basic concepts and principles to study host pathogen relationship. Molecular genetics, imaging and analytical chemistry tools for studying plants, microbes, and their interactions.

**Unit II** Different forms of plant-microbe interactions and nature of signals/effectors underpinning these interactions. Plant innate immunity: PAMP/DAMP. Molecular basis of host-pathogen interaction- fungi, bacteria, viruses and nematodes; recognition system, signal transduction.

**Unit III** Induction of defence responses- HR, programmed cell death, reactive oxygen species, systemic acquired resistance, induced systemic resistance, pathogenesis related proteins, phytoalexins and virus induced gene silencing. Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker- aided selection, pyramiding of R genes. Gene for gene systems: Background, genetics, phenotypes, molecular mechanisms, races, breakdown of resistance (boom-and-bust cycles), Coevolutionary- arms race and trench warfare models, Metapopulations, cost of resistance, cost of unnecessary virulence, GFG in agricultural crops vs. natural populations, Durability of resistance, erosion of quantitative resistance.

**Unit IV** Pathogen population genetics and durability, viruses vs cellular pathogens. Gene deployment, cultivar mixtures. Disease emergence, host specialization. Circadian clock genes in relation to innate immunity. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GMcrops.

**Practical** : Protein, DNA and RNA isolation, plasmid extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation. Gene mapping and marker assisted selection. Development and use of molecular markers in identification and characterization of resistance to plant pathogens and theirmanagement.

**Pl. Path.-605 Principles and Procedures of Certification** **1+0** **Sem. I**

**Unit I** Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control. Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health etc. Fixing tolerance limits fordiseases and insect pests in certification and quality control programmes.

**Unit II** Methods used in certification of seeds, vegetative propagules and in vitro cultures. Accreditation of seed testing laboratories. Role of seed/planting material health certification in national and international trade.

**Pl. Path.-606 Plant Biosecurity and Biosafety** **2+0** **Sem. II**

**Unit I** History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging / resurgence of pests and diseases. Introduction and History of biosecurity and its importance.

**Unit II** National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures. World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

**Unit III** Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops. Emerging/resurgence of pests and diseasesin the changing scenario of climatic conditions. Issues related to release of genetically modified crops.

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|---|---|
| **Pl. Path.-691 Seminar I** | **1+0** |
| **Pl. Path.-692 Seminar II** | **1+0** |
| **Pl. Path.-699 Ph.D Research** | **0+75** |

# SOIL SCIENCE

## PROGRAMMES

**M.Sc.SOIL SCIENCE**
**Ph.D.SOIL SCIENCE**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of Specialization | Pedology, Soil Chemistry, Soil Conservation, Soil Fertility, Soil Microbiology, Soil Physics |
| Core Courses | Soil-501, Soil-502, Soil-503, Soil-504 |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Supporting Courses | Courses from subject matter fields (other than minor) relating to area of special interest and research problem (as per BSMA) |
| Minor Fields | Agronomy, Biochemistry, Botany, Chemistry, Microbiology, Soil and Water Engineering, Vegetable Science, Agricultural Meteorology or any other as approved by Dean, Postgraduate Studies |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Pedology, Soil Chemistry, Soil Conservation, Soil Fertility, Soil Microbiology, Soil Physics |
| Core Courses | Soil-603, Soil-604 |
| Supporting Courses | Courses from subject matter fields (other than minor) relating to area of special interest and research problem (as per BSMA) |
| Minor Fields | Agronomy, Biochemistry, Botany, Chemistry, Microbiology, Soil and Water Engineering, Vegetable Science, Agricultural Meteorology or any other as approved by Dean, Postgraduate Studies |
| Deficiency courses | Soil-501, Soil-502, Soil-503, Soil-504 (for students other than Soil Science discipline) |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Courses

**Soils 51 Elementary Soil Fertility** **2+1** **Sem. I**

Components of soil. Function of soil for plant growth. Rocks and minerals. Weathering. Soil formingfactors and processes. Soil profile. Soils of Punjab. Essential nutrients-criteria of essentiality forms present in soil, functions and deficiency symptoms. Soil colloids-properties, types and importance for exchange-CEC and AEC. Organic matter and its mineralization. Soil organisms and their beneficialand harmful roles. Soil reaction, saline and sodic soils and their reclamation. Fertilizers and manures, lime and method of fertilizer application.

**Practical:** Identification of rocks and minerals. Study of soil profile. Visit to soil testing lab. Determination of pH, EC and organic carbon. Gypsum requirement of sodic soils. Identification of fertilizers. Diagnosis of nutrient deficiencies/symptoms in the field. Collection of soil samples for different purposes. Preparation of farm compost.

**Soils 52 Elementary Soil Physics and Conservation** **2+1** **Sem. II**

Soil as a three phase system-solid particles, water and air; Distribution of phase components in surface and subsoils; Soil texture – its importance and classification; Volume-mass relationships in soils; Soil structure- classification, significance and management; Soil water-retention and storage; Direct and indirect ways to measure soil water content; Plant available water; Soil water transmission characteristics including infiltration; Composition of soil air and its renewal; Soil temperature- thermal properties, diurnal and seasonal variations and management; Soil erosion by water – forms, causes and factor affecting; Mechanism of soil erosion by water and factors affecting it; Erosivity factors affecting and erosivity indices; Erodibility – factors affecting and erodibility indices; Soil erosion management including gully erosion control. Wind erosion – causes, factors, forms. Wind erosion management including shelterbelts and wind breaks.

**Practical:** Determination of particle size analysis (soil texture). Dry aggregate size analysis. Determination of soil bulk and particle densities. Determination of soil moisture by neutron scattering technique. Determination of soil moisture status by tensiometery. Determination of soil moisture characteristics. Determination of infiltration rate of soils. Determination of total and air filled pore spaces. Measurement of soil temperature. Determination of per cent surface cover by mulches and crop canopy. Measurement and estimation of runoff. Measurement of soil loss in runoff water.Determination of splash erosion. Visit to soil conservation works

## Undergraduate Courses

**Soils 101 Fundamentals of Soil Science** **2+1** **Sem. I**

Soil as a natural body, pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: soil-texture, structure, density, porosity, soil colour and consistence; Elementary knowledge of soil taxonomy classification and soils of India; Soil water retention, movement and availability; Soil air, composition, gaseous exchange, and plant growth, Soil temperature; source, amount and flow of heat in soil; effect on plant growth, Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; soil colloids - inorganic and organic; silicate clays: constitution andproperties; sources of charge; ion exchange, cation exchange capacity, base saturation; soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties; soil organisms: macro and microorganisms, their beneficial and harmful effects.

**Practical**: Study of soil profile in field. Collection of representative soil sample, its processing and storage. Study of soil forming rocks and minerals. Determination of particle andbulk densities, moisture content and porosity. Determination of soil texture by feel and laboratory methods. Determination of soil pH and

electrical conductivity. Determination ofcation exchange capacity of soil. Study of soil map. Determination of soil colour. Estimation of organic matter content of soil.

**Soils 102 Principles of Soil Science** **1+1 Sem. I**

**(For students of B.Tech. Agriculltural Engg.)**

Concepts of soil; soil forming rocks and minerals, their classification and composition, soil forming processes; soil physical properties and their importance; soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil reaction – acidic, saline and sodic soils; soil organic matter – its composition and decomposition, effect on soil fertility; quality of irrigation water; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganicfertilizers and their fates in soils.

**Practical**: Identification of rocks and minerals; Examination of soil profile in the field; Collection of Soil Sample; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Determination of Nitrogen, Determination of Phosphorus and Determination of Potassium; Identification of nutrient deficiency symptoms of crops in the field; Determination of water quality parameters.

**Soils 106 Soil and Water Management** **1+1 Sem. II**

**(For students of B.Sc. Agri-Business Management)**

Concept of soil, its meaning and definition. Components of Soil. Soil physical properties -Soil texture, structure, density, porosity, soil water, soil air, soil temperature. Soil chemical properties, Soil organic matter. Land capability classification and suitability. Soils of India and Punjab. Soil quality and soil health. Distribution of waste land/degraded lands and problem soils in India. Management of salt affected soils, calcareous soils, acid soils, acid sulphate soils, eroded and compacted soils, flooded/water logged soils, physically constrained soils, polluted soils. Alternate land use strategies for management of problematic soils including bioremediation/ phytoremediation. Irrigation water-quality and standards, utilization of poor-quality water in agriculture.**Practical**: Soil sample ollection and its preparation

**Env 101 Environmental Studies and Disaster Management** **2+0 Sem. I & II**

[For students of B.Sc. (Hons.) Agri., B.Tech. (Biotech.), B. Tech. (Food Technology), M.Sc. Integrated, B.Sc. Agri-Business Management, B.Sc. Community Science, B.Sc. Nutrition Dietics, B.Sc (Hons.) Horticulture]

Definition, scope and importance of environmental science. Natural Resources - renewable and non-renewable resources. Forest resources - use and over-exploitation. Water resources - use and over-utilization of surface and ground water, floods, drought. Mineral resources - use, exploitation and their environmental effects. Food resources - world food problems, challenges of modern agriculture. Energy resources - renewable and non-renewable. Land resources - land degradation and restoration. Ecosystems - concepts, types, structures and functions. Biodiversity at global, national and local levels, hot-spots of biodiversity, threats to biodiversity. Environmental Pollution - air, water, soil, marine, noise, thermal pollution and nuclear hazards. Solid waste management - causes, effects and control. Social issues and the environment - unsustainable to sustainable development. Water conservation - rain water harvesting, watershed management. Environmental ethics - issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Acts - air, water, wildlife protection, forest conservation. Human population and environment. Role of information technology in environment and human health. Natural disasters - nature, types and their effects. Climatic change - ozone depletion, global warming, sea level rise. Man-made disasters - types and their effects. Disaster management - concept ofdisaster management, national disaster management framework, financial arrangements,role of Government, NGOs, media and other organizations in disaster management. Visitsto ecologically important places and management organizations during weekends as a part of advisory and class tours by the respective departments/class incharges.

**Soils 202 Problematic Soils and their Management** **2+0 Sem. II**

Soil quality and health. Distribution of waste land and problem soils in India, their categorization based on properties. Reclamation and management of saline, sodic, acid, acid sulphate, eroded, compacted, flooded, waterlogged and polluted soils. Irrigation water – quality and standards. Utilization of saline and sodic water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils. Bioremediation of problem soils through multipurpose tree species. Land capability classification. Land suitability classification. Problematic soils under different agro-ecosystems.

**Soils 301 Manures, Fertilizers and Soil Fertility Management** **2+1 Sem. I**

Introduction and importance of organic manures. Properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management. Chemical fertilizers - classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary and micronutrient fertilizers, complex fertilizers and nano fertilizers. Soil amendments. Fertilizer storage. Fertilizer Control Order. History of soil fertility and plant nutrition. Criteria of essentiality, role, deficiency and toxicity symptoms of essential plant nutrients. Mechanisms of nutrient transport to plants. Critical levels of different nutrients in soil. Forms of nutrients in soil. Factors affecting nutrient availability to plants. Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation - Soil testing, plant analysis, rapid plant tissue tests, indicator plants. Factor influencing nutrient use efficiency (NUE), Time and methods of application of fertilizers under rainfed and irrigated conditions.

Precision agriculture - concepts and techniques, their issues and concerns for Indian agriculture. Definition (Nanoscience and Nanotechnology, Nanobiotechnology), History and timeline (Contribution of important scientific discoveries for the development of nanotechnology), Nanoscale effects. Types of nanomaterial, Basic information on top down and bottom up approaches for the synthesis of nanomaterials. Physical, chemical and biological approaches for synthesis of nanomaterials, Characterization techniques. Use of nanomaterials for enhancing crop productivity, Nanofertilizers and nanopesticides: basic concepts and application. Nanodiagnostics: Easy detection of phytopathogens using nano-based sensors. Global positioning system (GPS), components and its functions. Geographic information system (GIS), components and its functions. Spatial data and their management in GIS. Use of geospatial technologies in studying Crop stress (biotic/ abiotic). Geo-informatics - definition, concepts, tool and techniques. Use of Geo- informatics in precision agriculture. Remote sensing concepts. Application of Remote sensing in agriculture. Image processing and interpretation. Crop discrimination and yield monitoring. soil mapping and fertilizer recommendation using geospatial technologies. Crop simulation models. Uses of crop models for optimization of agricultural inputs. STCR approach for precision agriculture.

**Practical:** Preparation protocols of soil and plant samples for characterization using spectroscopy and electron microscopy tools. Role of stabilizers or surfactants for development of stable formulations and applications of nanoparticles for enhanced seed germination and growth, anti-microbial properties of nanomaterials. Use of GPS for agricultural survey, Introduction to GIS software, spatial data creation and editing. Crop stress (biotic/abiotic) monitoring using geospatial technology. Introduction to image processing software. Visual and digital interpretation of remote sensing images. Generation of spectral profiles of different objects. Supervised and unsupervised classification and acreage estimation. Multispectral remote sensing for soil mapping. Creation of thematic layers of soil fertility based on GIS. Creation of productivity and management zones. Fertilizers recommendations based on VRT and STCR techniques.

**Soils 303 Biofertilizers and Biopesticides** **2+1 Sem. II**

Biofertilizers - introduction, status and scope. Structure and characteristic features of bacterial biofertilizers - *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia,* cyanobacterial biofertilizers - *Anabaena*, *Nostoc*, *Hapalosiphon* and fungal biofertilizers - AM endomycorrhiza and ectomycorhiza. Nitrogen fixation - free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and mobilization, K solubilization. Production technology - strain selection, sterilization, growth and fermentation. Mass production of carrier based and liquid biofertilizers. Factors influencing the efficacy of biofertilizers. Application technology for seeds, seedlings, tubers and sets. Storage, shelf life, quality control and marketing of biofertilizers. FCO specifications for quality control of

biofertilizers.Biopesticides-History, concept, importance, scope and potential of biopesticides. Definitions and classification of biopesticides - pathogen, botanical pesticides and biorationales and their uses. Mass production technology of biopesticides. Virulence, pathogenicity and symptoms of entomopathogenic organisms. Methods of application of biopesticides. Quality control of biopesticides. Impediments and limitations in production and use of biopesticides. Registration of biopesticides.

**Practical:** Isolation, biochemical characterization and purification of *Azospirillum, Azotobacter, Rhizobium*, P-solubilizers, K-solubilizers and cyanobacteria. Mass multiplication and production of inocula of biofertilizers. Isolation of AM fungi - wet sieving method and sucrose gradient method. Mass production of AM inoculants. Isolation and purification of important biopesticides - *Trichoderma, Pseudomonas, Bacillus, Metarhyzium* and *Beauvaria* and their production. Techniquesof mass production of biopesticides. Equipment in biopesticide production. Field visit to naturally infected cadavers. Identification of entomopathogenic entities in field condition.

**Soils 304 Soil, Water and Plant Analysis** **1+1** **Sem. II**

**(For students of B.Sc. (Hons.) Agriculture and B.Sc (Hons.) Horticulture)**

Methods of soil, water and plant sampling and processing for analysis. Renewal of soil air. Methods of estimation of oxygen diffusion rate and redox potential. Use of radio tracer techniques in soil fertility evaluation and plant nutrient studies. Soil micro-organisms and their importance. Saline, alkali, calcareous, acidic, waterlogged and sandy soils, their appraisal and management. Mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values. Rapid tissue tests for plant. Quality of irrigation water. Management of poor quality irrigation water in crop production. Soil and water pollution.

**Practical:** Collection and preparation of soil, water and plant samples for analysis. Determination of moisture content and hydraulic conductivity of soil. Determination of pH, electrical conductivity, calcium carbonate, cation exchange capacity and exchangeable cations in soil, and estimation of exchangeable sodium percentage. Determination of gypsum and lime requirements of soil. Rapid tissue tests to assess nutrient status of plants. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples. Determination of carbonate, bicarbonate, chlorine, boron, calcium, magnesium, sodium and potassium in soil and irrigation water and estimation of sodium adsorption ratio.

**Soils 491 Agro-Industrial Attachment** **0+4** **Sem. I**

**Practical:** Fertilizer Industries, Vermicompost Units, Biofertilizer Units.

**Soils 492 Experiential Learning in Soil, Plant, Water and Seed Analyses** **0+20** **Sem. II**

## Postgraduate Courses

**Soil-501 Soil Physics** **2+1** **Sem. I**

**Unit I** Basic principles of physics applied to soils, soil as a three phase system.

**Unit II** Soil texture, textural classes, mechanical analysis, specific surface.

**Unit III** Soil consistence, dispersion and workability of soils; soil compaction and consolidation. Soil strength; swelling and shrinkage - basic concepts. Alleviation of soil physical constraints for crop production. Soil erosion and edibility.

**Unit IV** Soil structure - genesis, types, characterization and management soil structure. Soil aggregation, aggregate stability. Soil tilth, characteristics of good soil tilth. Soil crusting - mechanism, factors affecting and evaluation. Soil conditioners. Puddling, its effect on soil physical properties; clod formation.

**Unit V** Soil water: content and potential. Soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential. Soil-moisture characteristic curve, hysteresis, measurement of soil-moisture potential.

**Unit VI** Water flow in saturated and unsaturated soils. Poiseuille's law, Darcy's law, hydraulic conductivity, permeability and fluidity, hydraulic diffusivity, measurement of hydraulic conductivity in saturated and unsaturated soils.

**Unit VII** Infiltration, internal drainage and redistribution, evaporation; hydrologic cycle, field water balance. Soil-plant- atmosphere continuum.

**Unit VIII** Composition of soil air, renewal of soil air - convective flow and diffusion, measurement of soil aeration, aeration requirement for plant growth, soil air management.

**Unit IX** Modes of energy transfer in soils; energy balance, thermal properties of soil; measurement of soil temperature, soil temperature in relation to plant growth, soil temperature management.

**Practical :** Determination of B.D, P.D and mass volume relationship of soil. Mechanical analysis by hydrometer and international pipette method. Measurement of Atterberg limits. Aggregate analysis - dry and wet. Measurement of soil-water content by different methods. Measurement of soil-water potential by using tensiometer and gypsum blocks. Determination of soil-moisture characteristics curve and computation of pore-size, distribution. Determination of hydraulic conductivity under saturated and unsaturated conditions. Determination of infiltration rate of soil. Determination of aeration porosity and oxygen diffusion rate. Soil temperature measurements by different methods. Estimation of water balance components in bare and cropped fields.

**Soil-502 Soil Fertility and Fertilizer Use** **2+1** **Sem. I**

**Unit I** Soil fertility and soil productivity, fertility status of major soils group of India. Nutrient source– fertilizers and manures. Criteria of essentiality, Classification, Law of minimum and maximum. Essential plant nutrients - functions and deficiency symptoms. Nutrient uptake, nutrient interactions in soils and plants. Long term effect of manures and fertilizers on soil fertility and crop productivity;

**Unit II** Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification. Biological nitrogen fixation -types, mechanism, microorganisms and factors affecting. Nitrogenous fertilizers and their fate in soils. Management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

**Unit III** Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils. Factors affecting phosphorus availability in soils, phosphatic fertilizers - behavior in soils and management under field conditions. Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation. Management of potassium fertilizers under field conditions.

**Unit IV** Sulphur - source, forms, fertilizers and their behavior in soils. Role in crops and human health. Calcium and magnesium– factors affecting their availability in soils. Management of sulphur, calcium and magnesium fertilizers.

**Unit V** Micronutrients – critical limits in soils and plants, factors affecting their availability and correction of their deficiencies in plants. Role of chelates in nutrient availability.

**Unit VI** Common soil test methods for fertilizer recommendations. Quantity–intensity relationships. Soil test crop response correlations and response functions.

**Unit VII** Fertilizer use efficiency. Site-specific nutrient management, plant need based nutrient management, integrated nutrient management. Speciality fertilizers concept, need and category. Current status of speciality fertilizers use in soils and crops of India

**Unit VIII** Soil fertility evaluation-biological methods. Soil, plant and tissue tests. Soil quality in relation to sustainable agriculture. Determination of critical limit, DRIS.

**Unit IX** Definition and concepts of soil health and soil quality. Long term effects of fertilizers and soil quality.

**Practical :** Soil and plant sampling and processing for chemical analysis. Determination of soil pH, total and organic carbon in soil. Chemical analysis of soil for total and available nutrients (major and micro). Analysis of plants for essential elements (major and micro).

**Soil-503 Soil Chemistry** **2+1** **Sem. I**

**Unit I** Chemical (elemental) composition of the earth's crust, soils, rocks and minerals.

**Unit II** Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

**Unit III** Soil colloids- inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils. Diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids. Electrometric properties of soil colloids, sorption properties of soil colloids. Soil organic matter - fractionation of soil organic matter and different fractions. Characterization of OM. Clay-organic interactions.

**Unit IV** Ion exchange processes in soil.Cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement. Thermodynamics. Statistical mechanics. Anion and ligand exchange –inner sphere and outer-sphere surface complex formation. Fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions. Shift of PZC on ligand exchange, AEC, CEC. Experimental methods to study ion exchange phenomena and **Practical** implications in plant nutrition.

**Unit V** Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption. Precipitation-dissolution equilibria. Concept of quantity/intensity(Q/I)relationship. Step and constant-rate K. Management aspects.

**Unit VI** Chemistry of acid soils. Active and potential acidity. Lime potential, chemistry of acid soils, sub-soil acidity.

**Unit VII** Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments.

**Unit VIII** Chemistry and electrochemistry of submerged soils, geochemistry of micronutrients, environmental soil chemistry.

**Practical :** Preparation of saturation extract, measurement of pH, EC, CO, HCO, Ca, Mg, K and Na, Determination of CEC and AEC of soils, Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter, Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method ,Extraction of humic substances, Potentiometric and conductometric titration of soil humic and fulvic acids,(E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ(E4/E6) values at two pH values, Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm, Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved, Determination of titratable acidity of an acid soil by BaCl2-TEA method, Determination of Q/I relationship of potassium, Determination of lime requirement of an acid soil by buffer method, Determination of gypsum requirement of an alkali soil.

**Soil-504 Soil Mineralogy, Genesis and Classification** **2+1** **Sem. I**

**Unit I** Fundamentals of crystallography, space lattice, coordination **Theory**, isomorphism and polymorphism.

**Unit II** Classification, structure, chemical composition and properties of clay minerals. Genesis and transformation of crystalline and non-crystalline clay minerals. Identification techniques, amorphous soil constituents and other non-crystalline silicate minerals and their identification. Clay minerals in Indian soils, role of clay minerals in plant nutrition, interaction of clay with humus, pesticides and heavy metals.

**Unit III** Factors of soil formation. Soil formation models. Soil forming processes, weathering of rocks and mineral transformations. Soil profile. Weathering sequences of minerals with special reference to Indian soils.

**Unit IV** Concept of soil individual. Soil classification systems–historical developments and modern systems of soil classification with special emphasis on soil taxonomy. Soil classification. Soil mineralogy and soil maps–usefulness.

**Practical :** Separation of sand, silt and clay fraction from soil. Determination of specific surface area and CEC of clay. Identification and quantification of minerals in soil fractions. Morphological properties of soil profile in different land forms. Classification of soils using soil taxonomy.

**Soil-505 Soil Erosion and Conservation** **2+1 Sem. II**

**Unit I** History, distribution, identification and description of soil erosion problems in India.

**Unit II** Forms of soil erosion. Effects of soil erosion and factors affecting soil erosion. Types and mechanismsof water erosion. Raindrops and soil erosion, rainfall erosivity-estimation as EI30 index and kinetic energy. Factors affecting water erosion. Empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

**Unit III** Wind erosion- types, mechanism and factors affecting wind erosion. Extent of problem in the country.

**Unit IV** Principles of erosion control, erosion control measures – agronomical and engineering. Erosion control structures - their design and layout.

**Unit V** Soil conservation planning. Land capability classification. Soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

**Unit VI** Watershed management - concept, objectives and approach. Water harvesting and recycling. Flood control in watershed management. Socioeconomic aspects of watershed management. Case studiesin respect to monitoring and evaluation of watersheds. Use of remote sensing in assessment and planning of watersheds, sediment measurement.

**Practical :** Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index. Computation of kinetic energy of falling rain drops. Computation of rainfall erosivity index (EI30) using rain gauge data. Land capability classification of a watershed.Visits to a watersheds.

**Soil-506 Soil Biology and Biochemistry** **2+1 Sem. II**

**Unit I** Soil biota, soil microbial ecology, types of organisms in different soils. Soil microbial biomass, microbial interactions, un-culturable soil biota.

**Unit II** Microbiology and biochemistry of root-soil interface. Phyllosphere, soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Root rhizosphere and PGPR.

**Unit III** Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Biochemical composition and biodegradation of soil organic matter and crop residues, microbiology and biochemistry of decomposition of carbonaceous and proteinaceous materials. Cycles of important organic nutrients.

**Unit IV** Organic wastes and their use for production of biogas and manures. Biotic factors in soil development. Microbial toxins in the soil.

**Unit V** Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

**Unit VI** Biofertilizers–definition, classification, specifications, method of production and role in crop production. FCO specifications and quality control of biofertilizers.

**Unit VII** Biological indicators of soil quality. Bioremediation of contaminated soils. Microbial transformations of heavy metals in soil. Role of soil organisms in pedogenesis–important mechanisms and controlling factors. Soil genomics and bioprospecting. Soil sickness due to biological agents. Xenobiotics. Antibiotic production in soil.

**Practical :** Determination of soil microbial population. Soil microbial biomass carbon. Elemental composition,fractionation of organic matter and functional groups. Decomposition of organic matter in soil. Soilenzymes. Measurement of important soil microbial processes such as ammonification, nitrification, $N_2$ fixation, S oxidation, P solubilization and mineralization of other micronutrients.

**Soil-507 Radioisotopes in Soil and Plant Studies** **2+0 Sem. I**

**Unit I** Atomic structure, radioactivity and units; radioisotopes-properties and Decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter, artificial radioactivity;

Storage and handling of radioactive materials, half-life and decay constant, techniques for radioactive measurement in soil and plant sample

**Unit II** Principles and use of radiation monitoring instruments-proportional, Geiger Muller counter, solid and liquids cintillation counters; neutron Moisture meter, mass spectrometry, autoradiography; 15N enrichment by mass spectrophotometery/emission spectrometry

**Unit III** Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern; fertilizer use efficiency and cation exchange equilibria, use of 32P/65Zn in determination of A, E and L values of soil; carbon dating.

**Unit IV** Doses of radiation exposure, radiation safety aspects regulatory aspects, collection, storage and disposal of radioactive e-wastes

**Soil-508 Soil, Water and Air Pollution** **2+1** **Sem. II**

**Unit I** Soil, water and air pollution. Problems associated with agriculture, nature and extent.

**Unit II** Nature and sources of pollutants–agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc. Air, water and soil pollutants-their CPC standards and effect on plants, animals and human beings.

**Unit III** Sewage and industrial effluents–their composition and effect on soil properties/health, and plant growth and human beings. Soil as sink for waste disposal.

**Unit IV** Pesticides–their classification, behavior in soil and effect on soil microorganisms.

**Unit V** Toxic elements– their sources, behavior in soils. Effect on nutrients Availability. Effect on plant and human health.

**Unit VI** Pollution of water resources due to leaching of nutrients and pesticides from soil. Emission of green house gases–carbon dioxide, methane and nitrous oxide.

**Unit VII** Risk assessment of polluted soil. Remediation/amelioration of contaminated soil and water. Remote sensing applications in monitoring and management of soil and water pollution.

**Practical :** Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants and their processing. Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD). Measurement of coliform (MPN), nitrate and Ammoniacal nitrogen and phosphorus, heavy metal content in effluents, Heavy metals in contaminated soils and plants, Management of contaminants in soil and plants to safeguard food safety, Air sampling and determination of particulate matter and oxides of sulphur, $NO_2$ and $O_2$ conc.; Visit to various industrial sites to study the impact of pollutants on soil and plants.

**Soil-509 Remote Sensing and GIS Technique for Soil, Water and Crop Studies** **2+1** **Sem.I**

**Unit I** Introduction and history of remote sensing. Sources, propagation of radiations in atmosphere, interactions with matter. Basic concepts and principles, hardware and software requirements. Common terminologies of geographic information system (GIS).

**Unit II** Sensor systems-camera, microwave radiometers and scanners. Fundamentals of aerial photographs and multispectral imaging, hyperspectral imaging, thermal imaging. Image processing and interpretations.

**Unit III** Application of remote sensing techniques-land use soil surveys, crop stress and yield forecasting. Prioritization in watershed and drought management, waste land identification and management.

**Unit IV** Significance and sources of the spatial and temporal variability in soils. Variability in relation to size of sampling. Classical and geo-statistical techniques of evolution of soil variability.

**Unit V** Applications of GIS for water resources, agriculture, precision farming, disaster management, e governance, Agricultural Research Information System(ARIS).

**Practical** : Familiarization with different remote sensing equipments and data products. Interpretation of aerialphotographs and satellite data for mapping of land resources. Analysis of variability of different soil properties with classical and geostatistical techniques. Creation of data files in a database programme. Use of GIS for soil spatial simulation and analysis. To enable the students to conduct soil survey and interpret soil survey reportsin terms of land use planning.

**Soil-510 Analytical Technique and Instrumental Methods in Soil and Plant Analysis 0+2 Sem.I**

**Practical** : Preparation of solutions for standard curves. Indicators and standard solutions for acid base. Oxidation reduction and complexometric titration. Soil, water and plant sampling techniques, their processing and handling. Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium. Estimation of phosphorus, ammonium and potassium fixation capacities of soils.Principles of visible, ultraviolet and infra-red spectrophotometery. Atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery. Identification of minerals by X-ray by different methods. CHNS analyzer. Electrochemical titration of clays. Estimation of exchangeable cations (Na, Ca, Mg, K). Estimation of root cation exchange capacity. Wet digestion/fusion/ extraction of soil with aquaregia with soil for elemental analysis. Triacid/di-acid digestion of plant samples. Determination of available and total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in soils. Determination of total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in plants. Drawing normalized exchange isotherms. Measurement of redox potential.

**Soil-511 Management of Problem Soils and Water 2+1 Sem. I**

**Unit I** Area and distribution of problem soils–acidic, saline, sodic and physically degraded soils. Origin and basic concept of problematic soils and factors responsible.

**Unit II** Morphological features of saline, sodic and saline-sodic soils. Characterization of salt-affected soils-soluble salts, ESP, pH. Physical, chemical and microbiological properties.

**Unit III** Management of salt-affected soils. Salt tolerance of crops-mechanism and ratings. Salt stress meaning and its effect on crop growth. Monitoring of soil salinity in the field. Management principles for sandy, clayey, red lateritic and dryland soils.

**Unit IV** Acid soils-nature of soil acidity. Sources of soil acidity. Effect on plant growth. Lime requirement ofacid soils. Management of acid soils. Biological sickness of soils and its management.

**Unit V** Quality of irrigation water. Management of brackish water for irrigation. Salt balance under irrigation. Characterization of brackish waters, area and extent, relationship in water use and quality.

**Unit VI** Agronomic practices in relation to problematic soils. Cropping pattern for utilizing poor quality ground waters.

**Practical :** Characterization of acid, acid sulfate, salt-affected and calcareous soils. Determination of cations ($Na^+$, $K^+$, $Ca^{++}$ and $Mg^{++}$) in groundwater and soil samples. Determination of anions ($Cl^-$, $SO^{--}$, $CO$ - and 4 3 $HCO^-$ in ground waters and soil samples. Lime and gypsum requirements of acid and sodic soils.

**Soil-512 Land Degradation and Restoration 1+0 Sem. II**

**Unit I** Type, factors and processes of soil/land degradation and its impact on soil productivity including soil fauna, biodegradation and environment.

**Unit II** Land restoration and conservation techniques-erosion control, reclamation of salt-affected soils. Mine land reclamation. Afforestation. Organic products.

**Unit III** Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools. Monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation. Global issues for twenty first century.

**Soil-513 Soil Survey and Land Use Planning 2+0 Sem. II**

**Unit I** Soil survey and its types. Soil survey techniques- conventional and modern. Soil series–characterization and procedure for establishing soil series. Benchmark soils and soil correlations. Soil

survey interpretations. Thematic soil maps, cartography, mapping units, techniques for generation of soil maps. Application of remote sensing and GIS in soil survey and mapping of major soil group of India.

**Unit II** Landform–soil relationship. Major soil groups of India with special reference to respective states. Land capability classification and land irrigability classification. Land evaluation and land use type (LUT)– concept and application. Approaches for managing soils and landscapes in the framework ofagro-ecosystem.

**Unit III** Concept and techniques of land use planning; factors governing present landuse. Land evaluation methods and soil-site suitability evaluation for different crops. Land capability classification and constraints in application.

**Unit IV** Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production. Status of LUP in India.

**Soil-514 Introduction to Nanotechnology** **2+1** **Sem. II**

**Unit I** General introduction. Basics of quantum mechanics. Harmonic oscillator. Magnetic phenomena. Band structure in solids. Mössbauer effect and spectroscopy. Optical phenomena. Bond in solids. Anisotropy.

**Unit II** Nanostructures. Growth of compound semiconductors. Superlattices, self-assembled quantum dots, nano-particles, nanotubes and nanowires, fullerenes (buckballs, graphene). Nano fabrication and nano-patterning. Optical, X-ray, and electron beam lithography, self-assembled organic layers. Process of synthesis of nanopowders. Electrodeposition. Important nano materials.

**Unit III** Mechanical properties. Magnetic properties. Electrical properties. Electronic conduction with nanoparticles. Investigating and manipulating materials in the nano scale. Electron microscopy.

**Unit IV** Nano-biology. Interaction between biomolecules and nano-particle surface. Different types of inorganic materials used for the synthesis of hybrid nano-bioassemblies. Application of nano in agriculture. Current status of nanobiotechnology. Future perspectives of nanobiology. Nanosensors.

**Practical :** Sources of nanoparticles and its preparation by different approaches. Electrospinning and its use in agriculture and allied sector. Equipments used in Nanotechnology: its principle and uses. Acquaintances with different equipments used in nanotechnology. Synthesis and characterization of Ag and ZnO nanoparticles. Mode of action of ZnO nanoparticles against soil borne diseases. Study on efficacy of ZnO nanoparticles as seed treating agent on plant growth parameters

**Soil-515: System Approaches in Soil and Crop Studies** **2+0** **Sem. I**

**Unit I** Systems concepts- definitions, general characteristics, general systems **Theory**. Systems - thinking, dynamics, behavior and study.

**Unit II** Model - definition and types. Mathematical models and their types.

**Unit III** Modeling-concepts, objectives, processes. Abstraction techniques. Simulation models, their verification and validation, calibration.

**Unit IV** Representation of continuous systems simulation models- procedural and declarative. Simulation- meaning and threats, experiment, design and analysis.

**Unit V** Application of simulation models in understanding system behaviour. Optimizing system performance. Evolution of policy options under different soil, water, and nutrient, climatic and cultural conditions. Decision support system. Use of simulation models in decision support system.

**EMN-501: Electron Microscopy** **1+2** **Sem. I**

**Unit I** Understanding image formation, resolution of a microscope, numerical aperture, magnification, depth of field and depth of focus. Important lens defects and their correction

**Unit II** Scanning electron microscopy: construction; interaction of electrons with matter, modes of operation, image formation. EDS- Production and properties of X-rays, Chemical analysis by X-rays.

**Unit III** Construction and working principles of transmission electron microscopes. Image formation, resolving power, magnification, depth of focus, elementary treatment of image contrast. Bright field and dark field images, sample preparation techniques. Specialized electron microscopy techniques

**Unit IV** Specialized Microscopy Techniques: Fluorescence microscopy, biomolecule structure and localization in cell environment, advanced variants of fluorescence based techniques, Atomic force microscopy,fundamentals, operational modes of imaging, variants of AFM

**Practical :** Anatomy of SEM and Sputter Coater, Sample preparation protocol for physics/rock/clay, plant, animal and microbial samples and Imaging under SEM, X-ray analysis: Production and properties of X-rays, X-ray diffraction,effect of texture, particle size, spectrum, point and shoot analysis, spectrum analysis, point and shoot analysis, line analysis, X-ray mapping,elemental composition of varied samples, Anatomy of TEM and ultracut microscopy, preparation of grid for physical Sample and imaging under TEM, staining of sample for TEM (Positive and Negative staining), sample preparation protocol for plant, animal, microbial sample, preparation of resin blocks, Preparation of buffer and dye solution and sample preparation for fluorescence microscopy, Imaging and Image analysis using different filters (I3, A, D), Atomic force microscope: operation, Sample preparation of microbes (bacteria, fungus) and nematode, calibration of AFM parameters, imaging (non-contact and phase imaging), operations of image analysis software, image interpretation

**Soil-591 Seminar** **1+0**

**Soil-599 Master's Research Ph.D. courses** **0+30**

**Ph.D Courses**

**Soil-601 Recent Trends in Soil Physics** **2+0** **Sem. II**

**Unit I** Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system, soil-plant-atmospheric continuum (SPAC).

**Unit II** Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows. Development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity. Limitations of Darcy's law. Numerical solution for one dimensional water flow.

**Unit III** Theories of horizontal and vertical infiltration under different boundary conditions.

**Unit IV** Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations. Break-through curves.

**Unit V** Soil air and aeration, mass flow and diffusion processes. Thermal properties of soil, heat Transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil. Soil, Plant, Water relations- Plant uptake of soil moisture, water balance and energy balance in the field. Irrigation and water use efficiency.

**Unit VI** Soil crust and clod formation. Structural management of puddled rice soils. Soil conditioning-concept, soils conditioners-types, characteristics, working principles, significance in agriculture.

**Unit VII** Solar and terrestrial radiation measurement, dissipation and distribution in soil crops systems. Prediction of evapo-transpiration using aerodynamic and canopy temperature based models. Canopy temperature and leaf diffusion resistance in relation to plant water deficit. Evaluation of soil and plant water status using infrared thermometer.

**Soil-602 Modern Concept in Soil Fertility** **2+0** **Sem. II**

**Unit I** Nutrient availability-concept and relationships, modern concepts of nutrients availability. Soil colloids and nutrient availability. Soil amendments and availability maintenance of nutrients, soil solution and plant growth. Nutrient response functions and availability indices.

**Unit II** Nutrient movement in soils. Nutrient absorption by plants. Mechanistic approach to nutrient supply and uptake by plants. Models for transformation and movement of major micronutrients in soils.

**Unit III** Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils. Kinetic studies of nutrients in soils

**Unit IV** Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

**Unit V** Modern concepts in fertilizer application; soil fertility evaluation techniques. Role of soil tests in fertilizer use recommendations. Site specific nutrient management for precision agriculture.

**Unit VI** Monitoring physical, chemical and biological changes in soils. Permanent manorial trials and long- term fertilizer experiments. Soil productivity under long-term intensive- cropping. Direct, residual and cumulative effect of fertilizer use.

**Unit VII** Carbon-a nutrient central to soil fertility; carbon cycle in nature, stocks, pools and fluxes. Greenhouse effect and climate change. Carbon sequestration vis-à-vis sustenance of soil quality and crop productivity.

**Soil-603 Physical Chemistry of Soil** **2+0** **Sem. II**

**Unit I** Colloidal chemistry of inorganic and organic components of soils– their formation, clay organic interaction.

**Unit II** Predictive approaches for cation exchange equilibria thermodynamics, empirical and diffuse doublelayer Theory (DDL)- relationships among different selectivity coefficients. Structure and properties of diffuse double layer.

**Unit III** Thermodynamics of nutrient transformations in soils. Climate change effects on mineralogy and surface properties of variable charge. Cationic and anionic exchange and their models, molecular interaction.

**Unit IV** Adsorption/desorption isotherms Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation. Selective and non –selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials(citation of utility in agricultural system).

**Unit V** Common solubility equilibria-carbonates, iron oxide and hydroxides, aluminium silicate, aluminium phosphate; electrochemical properties of clays (citation of examples from agricultural use).

**Soil-604 Soil Genesis and Micromorphology** **2+0** **Sem. II**

**Unit I** Pedogenic evolution of soils. Soil composition and characterization.

**Unit II** Weathering and soil formation–factors and pedogenic processes. Stability and weathering sequences of minerals.

**Unit III** Assessment of soil profile development by mineralogical and chemical analysis.

**Unit IV** Micro-pedological features of soils–their structure, fabric analysis, role in genesis and classification.

**Soil-605 Biochemistry of Soil Organic Matter** **2+0** **Sem. I**

**Unit I** Organic matter in soils and its maintenance. Role of organic matter in soil productivity. Humus levels in soils. Current thinking on the maintenance of organic matter in the soils. Carbon retention and sequestration.

**Unit II** Biochemistry of the humus formation; different pathways for humus synthesis in soil. Soil carbohydrates and lipids.

**Unit III** Nutrient transformation–N, P, S. Trace metal interaction with humic substances, significance of chelation reactions in soils.

**Unit IV** Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes. Clay-organic matter complexes.

**Unit V** Humus-pesticide interactions in soil, mechanisms.

**Soil-606 Soil Resource Management** **3+0 Sem. I**

**Unit I** Relevance of soil management to sustainable agriculture. Soil as a natural resource for biomass production, filtering, buffering, transportation of solutes, gene reserves, and geogenic source of rawmaterials. Soil as a source and sink of greenhouse gases.

**Unit II** Concept of sustainable land management (SLM). Spatial variability of soils. Soil quality and food security. Soil quality indices, conservation agriculture in relation to soil quality. Soil resilience and resistance.

**Unit III** Types, factors and causes of land degradation and desertification. GLASOD classification. Application of GIS and remote sensing in monitoring, diagnosis and mapping land degradation. History, distribution, identification and description of soil erosion problems in India. Forms of soil erosion. Impact of soil erosion-onsite and off-site effects. Strategies for erosion control and conservation. Soil conservation in hilly, arid, semiarid, coastal and diara lands. Management of forest, peat and muck soils.

**Unit IV** Soil conservation planning. Land capability classification. Soil conservation in special problem are as such as hilly, arid and semiarid regions, waterlogged and wetlands. Land restoration and conservation techniques–erosion control, reclamation of salt affected soils. Mine land reclamation, afforestation, organic products, soil fauna and biodegradation.

**Unit V** Watershed management-concept, objectives and approach. Water harvesting and recycling. Flood control in watershed management. Socio-economic aspects of watershed management. Case studies in respect to monitoring and evaluation of watersheds.

**Unit VI** Agro-ecological regions of India. Potentials and constraints of soils of different regions. Land evaluation and rationalizing land use. Decision support system with relation to land management. National and international soil policy considerations.

**Soil-607 Modelling of Soil Plant System** **2+0 Sem. I**

**Unit I** Introduction, terms and definitions. Classification of models. Taylor series. Numerical methods of differentiation and integration.

**Unit II** High level computer language: FORTRAN-its commands and usage. Testing and evaluation of model.

**Unit III** Description of spatially homogeneous models. K transformation model. Nitrogen and phosphorus dynamics in soil.

**Unit IV** Spatially heterogeneous models. Equation of continuity. Simulation of water flow through soil. Explicit and Explicit-Implicit method. Simulation of solute movement through soil with variable moisture flux by explicit-implicit method.

**Unit V** Nutrient uptake model: Integration of nutrient movement in soil (mass flow and diffusion) and uptake by plants (Michaelis-Menten kinetics). Nutrient uptake model: Solubility and free ion activitymodel.

**Soil-608 Clay Mineralogy** **2+1 Sem. I**

**Unit I** Definition and concepts of clays and clay minerals. Fundamentals of crystallography – unit cell, external characteristics of crystals, crystallographic notations, crystal systems.

**Unit II** Structures and classification of silicate minerals, basics of phyllosilicates, laws governing structural characteristics of phyllosilicates, Goldschmitdt's laws – Laws I and Law II. Classification of Phyllosilicates.

**Unit III** Kaolonite group of minerals, Dioctahedral kaolins and Trioctahedral kaolins.

**Unit IV** Smectites, properties of smectites, reference models of structure, principal types based on Hofmann- Marshal-Hendricks (H-M-H) models, occurrence of smectites, transformation and formation in soils.

**Unit V** Micas: occurrence and origin in soils, polytypes of micas, structure and formation of muscovites andillite.

**Unit VI** Vermicullites: structure, occurrence in soils, formation, relation between vermiculites and montmorillonite.

**Unit VII** Chlorite: occurrence and structure of chlorites, “swelling chlorites”, formation of chlorite.

**Unit VIII** Non-crystalline clays (amorphous materials), subgroups and chemical composition, morphology and structure, physico-chemical properties, influence of non-crystalline clays on soil properties.

**Unit IX** Interstratified clay minerals, occurrence and formation in soils, regularly interstratified and partiallyrandom interstratified minerals.

**Unit X** Genesis and transformation of clay minerals, Generalized conditions for formation and persistenceof common clay-size minerals in soils.

**Unit XI** Surface chemistry of clay minerals, clay-organic complexes, nano clay mineralogy.

**Unit XII** Clay minerals in different soil orders, role of clay minerals in soil fertility management.

**Practical** : Separation of clay for mineralogical study. X-ray diffraction analysis of clay. Selective dissolution of clay minerals.IR, DTA and SEM of clay minerals. Identification and quantification of clay minerals. Determination of surface charge of clay minerals. Potentiometric titration of clay minerals.

**Soil-609 Recent Trends in Soil Microbial Biodiversity** **2+1** **Sem. I**

**Unit I** Microbial evaluation and biodiversity. Microbial communities in ecosystems. New insights in belowground diverse of plant performance.

**Unit II** Qualitative ecology of microorganisms. Biomass and activities.

**Unit III** Nitrogen fixing organisms. Trends in diversity of N fixing organisms. Molecular approaches in characterizing N fixing microorganisms.

**Unit IV** Serology and molecular characterization, ecological aspects of bio determination, soil waste and water management.

**Unit V** Biodegradability, testing and monitoring of the bioremediation of xerobiotic pollutants and bacterialfertilizers.

**Practical :** Determination of soil microbes using classical techniques. Determination of soil microbial diversityusing molecular techniques. Estimation of soil microbial biomass carbon, nitrogen and phosphorus. Estimation of key soil enzyme activities. Community level physiological profiling of microbial diversity.

**Soil-691 Seminar I** **1+0**

**Soil-692 Seminar II** **1+0**

**Soil-699 Ph.D. Research** **0+75**

# COURSE CURRICULUM FOR B.Sc. (Hons.) Agriculture
# 4 -YEAR PROGRAMME (CORE COURSES)

## DEFICIENCY COURSES

### BASIC SCIENCES AND HUMANITIES

| | | | Cr. Hrs. Th+Pr |
|---|---|---|---|
| | **For PCM base** | | |
| 1. | Bio. 102 | Introductory Biology | 1+1 |
| | | | **1+1=2** |
| | **For PCB base** | | |
| 1. | Math. 103 | Elementary Mathematics | 2+0 |
| | | | **2+0=2** |

**Regional Language**

For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level

| | | | |
|---|---|---|---|
| 1. | Pbi. 101 | Basic Punjabi | 0+2(NC) |
| | For ICAR nominees and | foreign students | |
| 2. | Pbi. Cul 101 | | Punjabi Culture |
| | 2+0 (NC) | | |

## REQUIRED COURSES

### BASIC SCIENCES AND HUMANITIES

| | | | |
|---|---|---|---|
| 1. | Biochem. 101 | Introduction to Biochemistry | 2+1 |
| 2. | Bot. 104 | Fundamentals of Crop Physiology | 1+1 |
| 3. | Econ. 102 | Fundamentals of Agricultural Economics | 2+0 |
| 4. | Econ. 204 | Agricultural Marketing, Trade and Prices | 2+1 |
| 5. | Econ. 205 | Agricultural finance and Cooperation | 2+1 |
| 6. | Econ. 304 | Farm Management, Production and Resource Economics | 1+1 |
| 7. | Eng. 101 | General English | 1+1 |
| 8. | Eng. 201 | Communication Skills and Personality Development | 1+1 |
| 9. | Micro. 102 | Elementary Microbiology | 2+1 |
| 10. | Mgt. 201 | Entrepreneurship Development and Business Management | 2+1 |
| 11. | Soc. 101 | Rural Sociology and Educational Psychology | 2+0 |
| 12. | Stat. 206 | Basic Statistics | 1+1 |
| | | | **19+10=29** |

## AGRICULTURAL ENGINEERING AND INFORMATION TECHNOLOGY

| | | | Th+Pr |
|---|---|---|---|
| 1. | EST 202 | Renewal Energy and Green Technology | 1+1 |
| 2. | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |
| 3 | FMP 102 | Farm Power and Machinery | 1+1 |
| 4 | PFE 303 | Protected Cultivation and Secondary Agriculture | 1+1 |
| 5 | SWE 102 | Soil and Water Conservation Engineering | 1+1 |
| | | | **5+6=11** |

## HORTICULTURE

| | | | |
|---|---|---|---|
| 1. | Forst. 102 | Introduction to Forestry | 1+1 |
| 2. | Flori. 202 | Production Technology for Ornamental Crops and Landscaping | 1+1 |
| 3. | Hort. 103 | Fundamentals of Horticulture | 1+1 |
| 4. | Hort. 202 | Production Technology for Fruit and Plantation Crops | 1+1 |
| 5. | Hort. 301 | Post-harvest Management and Value Addition of Fruits and Vegetables | 1+1 |
| 6. | Veg. 202 | Production Technology for Vegetables and Spices | 1+1 |
| | | | **6+6=12** |

## AGRICULTURE

| | | | |
|---|---|---|---|
| 1. | AS 201 | Livestock and Poultry Management | 2+1 |
| 2. | Agromet. 102 | Introductory Agrometeorology and Climate Change | 1+1 |
| 3. | Agron. 101 | Fundamentals of Agronomy | 3+1 |
| 4. | Agron. 201 | Production Technology for *Kharif* Crops | 1+1 |
| 5. | Agron. 202 | Crop Production Technology for *Rabi* Crops | 1+1 |
| 6. | Agron. 203 | Farming Systems and Sustainable Agriculture | 1+0 |
| 7. | Agron. 301 | Practical crop Production-I (*Kharif* Crops) | 0+2 |
| 8. | Agron. 302 | Practical crop Production-II (*Rabi* Crops) | 0+2 |
| 9. | Agron. 303 | Rainfed Agriculture and Watershed Management | 1+1 |
| 10. | Agron. 304 | Principles of Organic Farming | 1+1 |
| 11. | Biotech. 206 | Fundamentals of Plant Biotechnology | 2+1 |
| 12. | Ent. 201 | Fundamentals of Entomology | 3+1 |
| 13. | Pl. Path. 202 | Principles of Integrated Pest and Disease Management | 2+1 |
| 14. | Ent. 301 | Pest of Crops and Stored Grains and their Management | 2+1 |
| 15. | Ent. 302 | Management of Beneficial Insects | 2+1 |
| 16. | Ext. 101 | Agricultural Heritage | 1+0 |
| 17. | Ext. 201 | Fundamentals of Agricultural Extension Education | 2+1 |
| 18. | FT 313 | Principles of Food Science and Nutrition | 2+0 |
| 19. | PBG 102 | Fundamentals of Genetics | 2+1 |
| 20. | PBG 201 | Fundamentals of Plant Breeding | 2+1 |
| 21. | PBG 301 | Crop Improvement-I (*Kharif* Crops) | 1+1 |
| 22. | PBG 302 | Crop Improvement-II (*Rabi* Crops) | 1+1 |
| 23. | PBG 303 | Intellectual Property Rights | 1+0 |

| | | | |
|---|---|---|---|
| 24. | PBG 304 | Principles of Seed Technology | 1+1 |
| 25. | Pl. Path. 102 | Fundamentals of Plant Pathology | 3+1 |
| 26. | Pl. Path. 301 | Diseases of Field and Horticultural Crops and their Management –I | 2+1 |
| 27. | Pl. Path. 302 | Diseases of Field and Horticultural Crops and their Management –II | 2+1 |
| 28. | Soils 101 | Fundamentals of Soil Science | 2+1 |
| 29. | Soils 202 | Problematic Soils and their Management | 2+0 |
| 30. | Soils 301 | Manures, Fertilizers and Soil Fertility Management | 2+1 |
| 31. | Soils 302 | Precision farming, Geoinformatics and Nano-technology | 1+1 |
| 32. | Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| 33. | Optional Course-1 | | 2+1/1+2 |
| 34. | Optional Course-2 | | 2+1/1+2 |
| 35. | RAWE 401 | General Orientation and On-campus Training | 0+1 |
| 36. | RAWE 402 | Village Attachment | 0+8 |
| 37. | RAWE 403 | KVK and Research Station Attachment | 0+5 |
| 38. | RAWE 404 | Plant Clinic | 0+2 |
| 39. | AIA 491 | Agro-Industrial Attachment | 0+4 |
| 40. | ELP 492 | Experiential Learning Modules | 0+20 |
| 41. | Educational Tour | Compulsory Educational Tour | 0+2(NC) |
| | | | **55 +70=125** |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1. | HDFS 106 | Human Values | 1+0 |
| | | | **1+0=1** |

**NCC/NSO/NSS**

| | | | |
|---|---|---|---|
| 1. | NCC/NSO/NSS | (SEM-I) | 0 + 1 (NC) |
| 2. | NCC/NSO/NSS | (SEM-II) | 0 + 1 (NC) |
| 3. | NCC/NSO/NSS | (SEM-III) | 0 + 1 (NC) |
| 4. | NCC/NSO/NSS | (SEM-IV) | 0 + 1 (NC) |

Total credit hours requirement for B.Sc.(Hons.)Agri.Programme:180+2NC*+2NC**+4NC*** =188

*Educational Tour

**Pbi 101/Pbi Cul 101/

***NCC/NSS/NSO

# SEMESTER- WISE STUDY PROGRAMME OF B.Sc. (Hons) Agri.
# 4 YEAR PROGRAMME

## FIRST YEAR

| SEM I | | Th+P | SEM II | | Th+P |
|---|---|---|---|---|---|
| 1. | Bio. 102* /Math. 103* | 1+1/2+0 | 1. | Agromet. 102 | 1+1 |
| 2. | Agron. 101 | 3+1 | 2. | Env. 101 | 2+0 |
| 3. | Ext. 101 | 1+0 | 3. | Forst. 102 | 1+1 |
| 4. | Hort. 103 | 1+1 | 4. | PBG 102 | 2+1 |
| 5. | Soils 101 | 2+1 | 5. | Pl. Path. 102 | 3+1 |
| 6. | Biochem. 101 | 2+1 | 6. | FMP 102 | 1+1 |
| 7. | Eng. 101 | 1+1 | 7. | SWE 102 | 1+1 |
| 8. | Soc. 101 | 2+0 | 8. | Bot. 104 | 1+1 |
| 9. | HDFS 106 | 1+0 | 9. | Econ. 102 | 2+0 |
| 10. | Pbi 101**/Pbi Cult 101*** | 0+2/2+0(NC) | 10. | Micro. 102 | 2+1 |
| 11. | NCC/NSO/NSS | 0+1(NC) | 11. | NCC/NSS/NSO | 0+1 (NC) |
| | | **20+2(NC)+1(NC)=23** | | | **16+8+1(NC)=25** |

*Remedial Course Bio 102 for Non Medical stream and Math 103 for Medical stream students

** For students with Punjab domicile who have not taken Punjabi at Matric/10+2 level

*** For students admitted through ICAR and foreign students

## SECOND YEAR

| SEM III | | Th+P | SEM IV | | Th+P |
|---|---|---|---|---|---|
| 1. | Agron. 201 | 1+1 | 1. | Agron. 202 | 1+1 |
| 2. | AS 201 | 2+1 | 2. | Agron. 203 | 1+0 |
| 3. | Ent. 201 | 3+1 | 3. | Biotech. 206 | 2+1 |
| 4. | Ext. 201 | 2+1 | 4. | Ent. -Pl. Path. 202 | 2+1 |
| 5. | PBG 201 | 2+1 | 5. | Flori. 202 | 1+1 |
| 6. | CSE 101 | 1+2 | 6. | Hort. 202 | 1+1 |
| 7. | Econ. 205 | 2+1 | 7. | Soils 202 | 2+0 |
| 8. | Mgt. 201 | 2+1 | 8. | Veg. 202 | 1+1 |
| 9. | NCC/NSO/NSS | 0+1 NC | 9. | EST 202 | 1+1 |
| | | | 10. | Econ. 204 | 2+1 |
| | | | 11. | Stat. 206 | 1+1 |
| | | | 12. | NCC/NSO/NSS | 0+1 (NC) |
| | | **15+9+1(NC)=25** | | | **15+9+1 (NC)=25** |

## THIRD YEAR

| | SEM V | Th+P | | SEM VI | Th+P |
|---|---|---|---|---|---|
| 1. | Agron. 301 | 0+2 | 1. | Agron. 302 | 0+2 |
| 2. | Agron. 303 | 1+1 | 2. | Agron. 304 | 1+1 |
| 3. | Ent. 301 | 2+1 | 3. | Ent. 302 | 2+1 |
| 4. | FT 313 | 2+0 | 4. | PBG 302 | 1+1 |
| 5. | Hort. 301 | 1+1 | 5. | PBG 304 | 1+1 |
| 6. | PBG 301 | 1+1 | 6. | Pl. Path. 302 | 2+1 |
| 7. | PBG 303 | 1+0 | 7. | Soils 302 | 1+1 |
| 8. | Pl. Path. 301 | 2+1 | 8. | Econ. 304 | 1+1 |
| 9. | Soils 301 | 2+1 | 9. | PFE 303 | 1+1 |
| 10. | Eng. 201 | 1+1 | 10. | Optional Course-1 | 2+1/1+2 |
| 11. | Edu. Tour | 0+2 (NC) | 11. | Optional Course-2 | 2+1/1+2 |
| | | **13+9+2(NC)=24** | | | **14+12=26** |

## FOURTH YEAR

| | SEM VII | Th+P | | SEM VIII | Th+P |
|---|---|---|---|---|---|
| 1. | RAWE 401 | 0+1 | 1. | ELP 492 | 0+20 |
| 2. | RAWE 402 | 0+8 | | | |
| 3. | RAWE 403 | 0+5 | | | |
| 4. | RAWE 404 | 0+2 | | | |
| 5. | Agro-Industrial Attachment | 0+4 | | | |
| | | **0+20=20** | | | **0+20=20** |

### Optional Courses

(A student will have to opt for any two of the following courses during VI semester)

| S.No. | Course No. | Course Title | Credit Hours |
|---|---|---|---|
| 1. | Agromet. 301 | System Simulation and Agro-advisory | 2+1 |
| 2. | Agron. 305 | Weed Management | 2+1 |
| 3. | Biotech. 308 | Micropropagation Technologies | 1+2 |
| 4. | Flori. 301 | Landscaping Grading | 2+1 |
| 5. | FT 314 | Food Safety and Standards | 2+1 |
| 6. | Hort. 302 | Hi-tech Horticulture | 2+1 |
| 7. | PBG 305 | Molecular Breeding Technologies | 2+1 |
| 8. | Soils 303 | Biofertilizers and Biopesticides | 2+1 |
| 9. | Veg. 301 | Vegetable Breeding | 2+1 |

| | | | |
|---|---|---|---|
| 10. | Veg. 302 | Protected Cultivation | 2+1 |
| 11. | Chem. 308 | Chemistry of Agrochemicals | 2+1 |
| 12. | Jour. 302 | Agricultural Journalism | 2+1 |
| 13. | Mgt. 304 | Agribusiness Management | 2+1 |

### Agro-Industrial Attachment

(A student will opt for only one module out of the following 491 series courses under Agro-Industrial Attachment during VII semester)

| S. No. | Course No. | Course Title | Credit Hours | Modules |
|---|---|---|---|---|
| | Agron. 491 | Agro-industrial Attachment | 0+4 | Seed Industries<br>Herbicide Formulators |
| | Ent. 491 | Agro-industrial Attachment | 0+4 | (i) Commercial Honey Production, Hive and Apicultural Equipment and Honey Processing Manufacturing Units; Honey Trading, Processing, Packaging, Exporting and Marketing Units. |
| | Ent.-Pl. Path. 491 | Agro-industrial Attachment | 0+4 | Pesticide and Biopesticide Industries<br>Biocontrol Agents Production Units<br>Plant Quarantine Station<br>Virus free Potato Tuber Production Units |
| | FT 491 | Agro-industrial Attachment | 0+4 | Fruit and Vegetables Industry<br>Beverages Industry<br>Cereal Industry<br>Milk Industry |
| | Flori. 491 | Agro-industrial Attachment | 0+4 | Commercial Flower Nurseries<br>Flower Marketing Firms<br>Flower Seed Production and Landscaping Units |
| | Forst. 491 | Agro-industrial Attachment | 0+4 | High-tech Nursery (Tree Planting Stock Production) |
| | Hort. 491 | Agro-industrial Attachment | 0+4 | (i) Commercial Fruit Nurseries |
| | PBG 491 | Agro-industrial Attachment | 0+4 | Commercial Hybrid Seed Production Units |
| | Soils 491 | Agro-industrial Attachment | 0+4 | Fertilizer Industries<br>Vermicompost Units<br>Biofertilizer Units |
| | Veg. 491 | Agro-industrial Attachment | 0+4 | Commercial Vegetable Nurseries<br>Farms of Progressive Vegetable Growers |
| | Micro. 491 | Agro-industrial Attachment | 0+4 | Mushroom Production Units |

## Experiential Learning Modules

(A student will opt for only one of the following Experiential Learning Modules during VIII semester)

| S. No. | Course No. | Course Title | Credit Hours |
|---|---|---|---|
| 1. | Agron. 492 | Experiential Learning in Organic Production Technology | 0+20 |
| 2. | Ent. 492 | Experiential Learning in Commercial Apiculture | 0+20 |
| 3. | Ent. -Pl. Path. 492 | Experiential Learning in Production Technology for Bioagents | 0+20 |
| 4. | Flori. 492 | Experiential Learning in Commercial Floriculture and Landscaping | 0+20 |
| 5. | Forst. 492 | Experiential Learning in Nursery Production of Agro-forestry Trees | 0+20 |
| 6. | Hort. 492 | Experiential Learning in Commercial Horticulture | 0+20 |
| 7. | PBG 492 | Experiential Learning in Seed Production and Technology | 0+20 |
| 8. | Soils 492 | Experiential Learning in Soil, Plant Water , and Seed Analyses | 0+20 |
| 9. | Veg. 492 | Experiential Learning in Commercial Vegetable Production | 0+20 |
| 10. | FT 492 | Experiential Learning in Food Technologies | 0+20 |
| 11. | EST 492 | Experiential Learning in Agricultural Waste Management | 0+20 |
| 12. | Micro. 492 | Experiential Learning in Mushroom Production | 0+20 |
| 13. | Micro. 493 | Experiential Learning in Production Technology for Biofertilizers | 0+20 |

## Semester Wise Total Credit Hours

| Semester | Credit Hours |
|---|---|
| I | 20(14+6/15+5)+2(NC**)+1(NC***)=23 |
| II | 24(16+8)+1(NC***)=25 |
| III | 24(15+9)+1(NC***)=25 |
| IV | 24(15+9)+ 1(NC***)=25 |
| V | 22(13+9)+2(NC*)=24 |
| VI | 26(14+12) |
| VII | 20(0+20) |
| VIII | 20(0+20) |
| TOTAL | 180+2NC*+2NC**+4NC***=188 |

*Educational Tour

**Pbi 101/Pbi Cul 101/

***NCC/NSS/NSO

# COURSE CURRICULUM FOR B.Sc. (Hons) Agri. 2+4 PROGRAMME
# CORE COURSES FOR FIRST TWO YEARS

| | | | |
|---|---|---|---|
| **COLLEGE OF AGRICULTURE** | | | **Th+Pr** |
| 1. | Ort. 91 | Orientation | 0+1NC |
| **BASIC SCIENCES AND HUMANITIES** | | | |
| 1. | Agri. I | Introduction to Agriculture | 1+0 NC |
| 2. | Agri. II | Agricultural Status of Punjab | 1+0 NC |
| 3. | Agri. III | Agricultural Status of India | 1+0 NC |
| 4. | Bot. 91 | Introduction to Morphology and Reproductive Botany | 3+1 |
| 5. | Bot. 92 | Basics of Systematic Botany and Ecology | 3+1 |
| 6. | Bot. 93 | Introduction to Plant Histology and Genetics | 3+1 |
| 7. | Bot. 94 | Basics of Plant Physiology | 3+1 |
| 8. | Chem. 91 | Fundamentals of Inorganic Chemistry | 3+1 |
| 9. | Chem. 92 | Introductory Organic Chemistry | 3+1 |
| 10. | Chem. 93 | Fundamentals of Physical Chemistry | 3+1 |
| 11 | Chem. 94 | Fundamentals of Organic Chemistry | 3+1 |
| 12. | Eng. 91 | General Reading, Vocabulary Building and Translation | 2+1 |
| 13. | Eng. 92 | Reading, Comprehension, Paragraph Writing and Applied Grammar | 2+1 |
| 14. | Eng. 93 | Conversational Structure and Communicative Function | 2+1 |
| 15. | Eng. 94 | Discourse Patterns in Spoken English | 1+2 |
| 16. | Phys. 91 | Mechanics | 3+1 |
| 17. | Phys. 92 | Matter Properties and Thermodynamics | 3+1 |
| 18. | Phys. 93 | Electricity and Magnetism | 3+1 |
| 19. | Phys. 94 | Modern Physics | 3+1 |
| 20. | Zoo. 91 | Elementary Cell Biology | 3+1 |
| 21. | Zoo. 92 | Elementary Animal Diversity | 3+1 |
| 22. | Zoo. 93 | Elementary Animal Physiology | 3+1 |
| 23. | Zoo. 94 | Human Welfare and Environment | 3+1 |

# SEMESTER- WISE STUDY PROGRAMME OF
# B.Sc. (Hons) Agri. 2+4YEAR PROGRAMME FOR FIRST TWO YEARS

## FIRST YEAR

| **SEM I** | | | **SEM II** | | |
|---|---|---|---|---|---|
| 1 | Phys. 91 | 3+1 | 1 | Phys. 92 | 3+1 |
| 2 | Chem. 91 | 3+1 | 2 | Chem. 92 | 3+1 |
| 3 | Bot. 91 | 3+1 | 3 | Bot. 92 | 3+1 |
| 4 | Zoo. 91 | 3+1 | 4 | Zoo. 92 | 3+1 |
| 5 | Eng. 91 | 2+1 | 5 | Eng. 92 | 2+1 |
| 6 | Ort. 91 | 0+1NC | | Agri I | 1+0 NC |
| | **14+5 = 19+1 NC** | | | **14+5 = 19+1 NC** | |

## SECOND YEAR

| SEM I | | | SEM II | |
|---|---|---|---|---|
| 1 | Phys. 93 | 3+1 | Phys. 94 | 3+1 |
| 2 | Chem. 93 | 3+1 | Chem. 94 | 3+1 |
| 3 | Bot. 93 | 3+1 | Bot. 94 | 3+1 |
| 4 | Zoo. 93 | 3+1 | Zoo. 94 | 3+1 |
| 5 | Eng. 93 | 2+1 | Eng. 94 | 1+2 |
| 6 | Agri II | 1+0 NC | Agri III | 1+0 NC |
| | **14+5 = 19+1 NC** | | **13+6 = 19+ 1 NC** | |

**Note :**

1. All courses given in RIB 2016 for B.Sc. (Hons) Agri. 4-year programme will also be applicable to B.Sc. (Hons) Agri. 2+4 programme from 3rd year onwards
2. The students of B.Sc. (Hons) Agri. 2+4 programme will be exempted from clearing Bio. 102 (1+1) courses equivalent to 10+2 medical stream as they will clear 16 credit hours each in Botany (Bot. 91, Bot. 92, Bot. 93 and Bot. 94) and Zoology (Zoo 91, Zoo. 92, Zoo. 93 and Zoo. 94) during initial two years.
3. The students who join 3rd year of B.Sc. (Hons) Agri. 2+4 programme at PAU, Ludhiana after completion of two years at IOA, Bathinda and IOA, Gurdaspur will register compulsory three fold programme of NCC / NSO /NSS (0+1 NC) during their first four semesters at PAU, Ludhiana.

# COURSE CURRICULUM FOR B.Tech. (Food Technology)
# 4 YEARS PROGRAMME (CORE COURSES)

## DEFICIENCY COURSES

### BASIC SCIENCES AND HUMANITIES

**Regional Language**

For student with domicile of Punjab who have not taken Punjabi at Matric/10+2 level

| | | | Th+pr |
|---|---|---|---|
| 1. | Pbi.101 | Basic Punjabi | 0+2 (NC) |

For ICAR nominees foreign students

| | | | |
|---|---|---|---|
| 1. | Pbi. Cul 101 | Punjabi Culture | 2+0 (NC) |

## REQUIRED COURSES

### BASIC SCIENCES AND HUMANITIES

| | | | Th+Pr |
|---|---|---|---|
| 1. | Math. 101 | Basic Mathematics-I | 3+0 |
| 2. | Env.101 | Environmental Studies & Disaster Management | 2+0 |
| 3. | Eng. 101 | General English | 1+1 |
| 4. | Micro. 103 | General Microbiology | 2+1 |
| 5. | HDFS 106 | Human Values | 1+0 |
| 6. | Math.102 | Basic Mathematics-II | 3+0 NC |
| 7. | Micro.104 | Food Microbiology | 2+1 |
| 8. | Eng.201 | Communication Skills and Personality Development | 1+1 |
| 9. | Mgt. 202 | Marketing Management and International Trade | 2+0 |
| 10. | Math.205 | Higher Mathematics-I | 2+0 |
| 11. | Stat. 205 | Statistics Methods and Numerical Analysis | 2+1 |
| 12. | Biochem. 208 | Food Biochemistry and Nutrition | 2+1 |
| 13. | Math.206 | Higher Mathematics-II | 2+0 |
| 14. | Mgt. 204 | Business Management and Economics | 2+0 |
| 15. | Micro. 308 | Fundamental of Industrial Microbiology | 2+1 |
| | | | 26+7+3NC=36 |

### AGRICULTURE

| | | | |
|---|---|---|---|
| 1. | Agron. 105 | Crop Production Practices | 2+1 |
| 2. | FT 102 | Food Chemistry of Macro constituents | 2+1 |
| 3. | FT 201 | Fundamentals of Food Processing | 1+1 |
| 4. | FT 202 | Processing Technology of Liquid Milk | 1+1 |
| 5. | FT 203 | Food Additives and Preservatives | 1+1 |
| 6. | FT 204 | Food Chemistry of Micro constituents | 2+1 |
| 7. | FT 205 | Processing Technology of Meat and Poultry products | 2+1 |
| 8. | FT 206 | Technology of Bakery, Confectionery and Snack Foods | 2+1 |
| 9. | FT 207 | Processing Technology of Legumes and Oilseeds | 2+1 |

| | | | |
|---|---|---|---|
| 10. | FT 208 | Processing Technology of Spices and Plantation Crops | 1+1 |
| 11. | FT 301 | Processing Technology of Fruits and Vegetables | 2+1 |
| 12. | FT 302 | Processing Technology of Cereals | 2+1 |
| 13. | FT 303 | Processing Technology of Dairy Products | 2+1 |
| 14. | FT 304 | Sensory Evaluation of Food Products | 2+1 |
| 15. | FT 305 | Instrumental Techniques in Food Analysis | 1+2 |
| 16. | FT 306 | Food Plant Sanitation | 1+1 |
| 17. | FT 307 | Processing Technology of Fish and Marine Products | 1+1 |
| 18. | FT 308 | Processing Technology of Beverages | 2+1 |
| 19. | FT 309 | Food Quality, Safety Standards and Certification | 2+0 |
| 20. | FT 310 | Food Packaging Technology and Equipment | 2+1 |
| 21. | Biotech. 308 | Food Biotechnology | 2+1 |
| 22. | FT/Mgt. 493 | Entrepreneurship Development | 2+1 |
| 23. | FT 494 | Student READY- Experiential Learning Programme –I | 0+7 |
| 24. | FT 495 | Student READY- Experiential Learning Programme-II | 0+7 |
| 25. | FT 496 | Student READY-Research Project | 0+3 |
| 26. | FT 497 | Student READY- Seminar | 0+1 |
| 27. | FT 498 | Student READY- Industrial cum Educational Tour | 0+2 |
| 28. | FT 499 | Student READY- IN-Plant Training | 0+20 |
| | | | 37+62=99 |

**AGRICULTURAL ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1. | EE 101 | Electrical Engineering | 2+1 |
| 2. | ME 101 | Workshop Technology | 1+2 |
| 3. | CSE 204 | Computer Programming and Data Structures | 1+2 |
| 4. | EE 206 | Applied Electronics and Instrumentation | 2+1 |
| 5. | ME 102 | Engineering Drawing and Graphics | 0+3 |
| 6. | ME 106 | Food Thermodynamics | 2+1 |
| 7. | PFE 102 | Post Harvest Engineering | 2+1 |
| 8. | ME 201 | Heat and Mass Transfer in Food Processing | 2+1 |
| 9. | PFE 201 | Unit Operations in Food Processing-I | 2+1 |
| 10. | PFE 202 | Unit Operations in Food Processing-II | 2+1 |
| 11. | PFE 203 | Food Refrigeration and Cold Chain | 2+1 |
| 12. | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |
| 13. | PFE 301 | Food Process Equipment Design | 2+1 |
| 14. | PFE 302 | Food Storage Engineering | 2+1 |
| 15. | EE 304 | Instrumentation and Process Control in Food | 2+1 |
| 16. | ME 305 | Fluid Mechanics | 2+1 |
| | | | 27+21=48 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1. | HDFS 106 | Human Values | 1+0 |

**NCC/NSO/NSS**

| | | | |
|---|---|---|---|
| 1. | NCC/NSO/NSS | SEM I | 0+1 NC |
| 2. | NCC/NSO/NSS | SEM II | 0+1 NC |
| 3. | NCC/NSO/NSS | SEM III | 0+1 NC |
| 4. | NCC/NSO/NSS | SEM IV | 0+1 NC |

Total credit hours requirement for B.Tech (Food Technology) 4 Year Programme :
180+7 (NC**)+2(NC)*= 189
*Pbi 101/Pbi Cul 101/ **NCC/NSS/NSO

# SEMESTER-WISE STUDY PROGRAMME OF
# B.Tech (Food Technology) PROGRAMME

## FIRST YEAR

| | SEM I | | | SEM II | |
|---|---|---|---|---|---|
| 1. | Math 101 | 3+0 | 1. | Math 102 | 3+0NC |
| 2. | Agron 105 | 2+1 | 2. | FT 102 | 2+1 |
| 3. | Env 101 | 2+0 | 3. | CSE 204 | 1+2 |
| 4. | EE 101 | 2+1 | 4. | EE 206 | 2+1 |
| 5. | ME 101 | 1+2 | 5. | ME 102 | 0+3 |
| 6. | Eng 101 | 1+1 | 6. | ME 106 | 2+1 |
| 7. | Micro 103 | 2+1 | 7. | PFE 102 | 2+1 |
| 8. | HDFS 106 | 1+0 | 8. | Micro 104 | 2+1 |
| 9. | *Pbi/Pbi.Cul 101 | 0+2/2+0 NC | 9. | NCC/NSO/NSS | 0+1NC |
| 10. | NCC/NSO/NSS | 0+1 NC | | | 11+10+4NC=25 |
| | | 14+6+2NC+1NC=23 | | | |

## SECOND YEAR

| | SEM III | | | SEM IV | |
|---|---|---|---|---|---|
| 1. | FT 201 | 1+1 | 1. | FT 205 | 2+1 |
| 2. | FT 202 | 1+1 | 2. | FT 206 | 2+1 |
| 3. | FT203 | 1+1 | 3. | FT 207 | 2+1 |
| 4. | FT204 | 2+1 | 4. | FT 208 | 1+1 |
| 5. | ME 201 | 2+1 | 5. | PFE 202 | 2+1 |
| 6. | PFE 201 | 2+1 | 6. | PFE 203 | 2+1 |
| 7. | Eng.201 | 1+1 | 7. | Biochem. 208 | 2+1 |
| 8. | Mgt. 202 | 2+0 | 8. | Math.206 | 2+0 |
| 9. | Math. 205 | 2+0 | 9. | Mgt.204 | 2+0 |
| 10. | Stat. 205 | 2+1 | 10. | NCC/NSO/NSS | 0+1NC |
| 11. | NCC/NSO/NSS | 0+1NC | | | 17+7+1NC=25 |
| | | 16+8+1NC=25 | | | |

## THIRD YEAR

| | SEM V | | | SEM VI | |
|---|---|---|---|---|---|
| 1. | FT 301 | 2+1 | 1. | FT 306 | 1+1 |
| 2. | FT 302 | 2+1 | 2. | FT 307 | 1+1 |
| 3. | FT 303 | 2+1 | 3. | FT 308 | 2+1 |
| 4. | FT 304 | 2+1 | 4. | FT 309 | 2+0 |
| 5. | FT 305 | 1+2 | 5. | FT 310 | 2+1 |
| 6. | CSE 101 | 1+2 | 6. | Biotech. 308 | 2+1 |
| 7. | PFE 301 | 2+1 | 7. | EE 304 | 2+1 |
| 8. | PFE 302 | 2+1 | 8. | ME 305 | 2+1 |
| | | 14+10=24 | 9. | Micro. 308 | 2+1 |
| | | | | | 16+8=24 |

## FOURTH YEAR

| SEM VII | | | SEM VIII | | |
|---|---|---|---|---|---|
| 1. | FT/Mgt 493 | 2+1 | 1. | FT 499 | 20 (0+20) |
| 2. | FT 494 | 0+7 | | | |
| 3. | FT 495 | 0+7 | | | |
| 4. | FT 496 | 0+3 | | | |
| 5. | FT 497 | 0+1 | | | |
| 6. | FT 498 | 0+2 | | | |
| | | 2+21=23 | | | 0+20=20 |

*For students with the domicile of Punjab who do not study Punjabi at matric or 10+2 level.

### Semester Wise Total Credit Hours

| Sr. No | Semester | Credit Hours |
|---|---|---|
| 1. | Semester-I | 20 (14+6)+2NC + 1NC=23 |
| 2. | Semester-II | 21 (11+10)+4NC= 25 |
| 3. | Semester-III | 24 (16+8)+1NC =25 |
| 4. | Semester-IV | 24 (17+7) +1NC =25 |
| 5. | Semester-V | 24 (14+10) = 24 |
| 6. | Semester-VI | 24 (16+8)=24 |
| 7. | Semester-VII | 23 (2+21)= 23 |
| 8. | Semester-VIII | 20 (0+20) =20 |
| | | 180(90+90)+7NC**+2NC*=189 |

*Pbi 101/Pbi Cul 101/
**NCC/NSS/NSO

# COURSE CURRICULUM FOR B.Tech. (Biotechnology)
# 4- YEAR PROGRAMME (CORE COURSES)

## DEFICIENCY COURSES

### BASIC SCIENCES AND HUMANITIES

**For PCM base**

| | | | **Cr. Hrs.** |
|---|---|---|---|
| | | | Th+Pr |
| 1. | Bot. 101 | Basic Botany | 2+1 |
| 2. | Zoo. 101 | Basic Zoology | 2+1 |
| | | | 4+2=6 |

**For PCB base**

| | | | |
|---|---|---|---|
| | | | Th+Pr |
| 1. | Math. 101 | Basic Mathematics-I | 3+0 |
| 2. | Math. 102 | Basic Mathematics-II | 3+0 |
| | | | 6+0=6 |

**Regional Language**

For students with domicile of Punjab who have not taken Punjabi at Matric /10+2 level

| | | | |
|---|---|---|---|
| 1. | Pbi.101 | Basic Punjabi | 0+2 NC |

For ICAR nominees and foreign students

| | | | |
|---|---|---|---|
| 1. | Pbi. Cul.101 | Punjabi Culture | 2+0 NC |

## REQUIRED COURSES

### AGRICULTURE

| | | | Th+Pr |
|---|---|---|---|
| 1. | Agron. 103 | Crop Production Technology | 2+1 |
| 2. | AS 201 | Livestock Production Management | 2+1 |
| 3. | Biotech. 101 | Cell Biology | 2+0 |
| 4. | Biotech. 102 | Molecular Biology | 2+1 |
| 5. | Biotech. 103 | Introduction to Biotechnology | 2+1 |
| 6. | Biotech. 104 | Plant Tissue Culture | 2+1 |
| 7. | Biotech. 106 | Electronics and Instrumentation in Biotechnology | 1+1 |
| 8. | Biotech. 201 | Recombinant DNA Technology | 2+1 |
| 9. | Biotech. 202 | Introductory Bioinformatics | 2+1 |
| 10. | Biotech. 203 | Plant Genetic Transformation | 2+1 |
| 11. | Biotech. 204 | Classical and Molecular Cytogenetics | 2+1 |
| 12. | Biotech. 301 | Molecular Genetics | 2+0 |
| 13. | Biotech. 302 | Nanobiotechnology | 2+0 |
| 14. | Biotech. 303 | Molecular Marker Technology | 2+0 |
| 15. | Biotech. 304 | Genomics and Proteomics | 3+0 |

| | | | |
|---|---|---|---|
| 16. | Biotech. 305 | Biosafety, Bioethics and IPR | 2+0 |
| 17. | Biotech. 306 | Computational Biology | 2+1 |
| 18. | Biotech. 310 | Applications of Genomics and Proteomics | 2+1 |
| 19. | Biotech. 311 | Molecular Breeding | 2+1 |
| 20. | Biotech. 312 | Epigenetics and Gene Regulation | 3+0 |
| 21. | Biotech. 313 | Programming for Bioinformatics | 2+2 |
| 22. | Biotech. 314 | Next Generation Sequencing and Data analysis | 2+1 |
| 23. | Biotech. 491 | In-house Skill Development in plant Biotechnology | 0+20/ |
| 24. | Biotech. 492 | In-house Skill Development in Bioinformatics | 0+20 |
| 25. | Biotech. 493 | Project Formulation, Execution and Presentation | 0+10 |
| 26. | Biotech. 494 | Entrepreneurial Development in Biotechnology | 0+10 |
| 27. | PI. Path 203 | Fundamental Crop Protection | 2+1 |
| 28. | Env.101 | Environmental Studies and Disaster Management | 2+0 |
| 29. | FT 101 | Food Science and Processing | 1+1 |
| 30. | Hort. 201 | Production Technologies for Horticulture Crops | 2+1 |
| 31. | PBG 102 | Fundamental of Genetics | 2+1 |
| 32. | PBG 201 | Fundamental of Plant Breeding | 2+1 |
| 33. | PBG 301 | Crop Improvement-I ( Kharif Crops) | 1+1 |
| 34. | PBG 302 | Crop Improvement-II (Rabi Crops) | 1+1 |
| 35. | Edu. Tour | Educational Tour | 0+2NC |
| | | | 58+63=121+2(NC) |

**AGRICULTURAL ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |
| | | | 1+2=3 |

**BASIC SCIENCES AND HUMANITIES**

| | | | |
|---|---|---|---|
| 1. | Biochem. 207 | Basic Biochemistry | 3+1 |
| 2. | Biochem. 304 | Enzymology and Enzyme Technologies | 2+1 |
| 3. | Bio. 103 | Biodiversity and its Conservation | 2+0 |
| 4. | Bot. 201 | Plant Physiology | 2+1 |
| 5. | Econ. 201 | Economics and Marketing | 2+1 |
| 6. | Eng.101 | General English | 1+1 |
| 7. | Eng. 201 | Communication Skills and Personality Development | 1+1 |
| 8. | Math. 207 | Biomathematics | 2+1 |
| 9. | Mgt. 201 | Entrepreneurship Development and Business Management | 2+1 |
| 10. | Micro. 102 | Elementary Microbiology | 2+1 |
| 11. | Micro 201 | Microbial Genetics | 2+1 |
| 12. | Phy. 202 | Fundamentals of Biophysics | 2+1 |
| 13. | Stat. 206 | Basic Statistics | 1+1 |
| 14. | Stat. 302 | Fundamentals of Biostatistics | 2+1 |
| 15. | Zoo. 312 | Immunology | 2+1 |
| 16. | Zoo 313 | Animal Biotechnology | 3+1 |
| | | | 31+15=46 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1. | HDFS 106 | Human Values | 1+0 |
| | | | 1+0=1 |

**NCC/NSO/NSS**

| | | | |
|---|---|---|---|
| 1. | NCC/NSO/NSS | (SEM-I) | 0+1(NC) |
| 2. | NCC/NSO/NSS | (SEM-II) | 0+1(NC) |
| 3. | NCC/NSO/NSS | (SEM-III) | 0+1(NC) |
| 4. | NCC/NSO/NSS | (SEM-IV) | 0+1(NC) |

Total credit hour requirements for B.Tech. (Biotechnology) 4 year Programme
177+2NC*+2NC**+4NC***=185

*Educational Tour
**Pbi 101/ Pbi Cul 101
***NCC/NSS/NSO

# SEMESTER-WISE STUDY PROGRAMME OF
# B.Tech. (Biotechnology) PROGRAMME

## FIRST YEAR

| | SEM I | | | SEM II | |
|---|---|---|---|---|---|
| 1. | *Bot. 101/<br>*Math. 101 | 2+1/<br>3+0 | 1. | *Zoo. 101/<br>*Math. 102 | 2+1/<br>3+0 |
| 2. | Biotech.101 | 2+0 | 2. | Biotech.102 | 2+1 |
| 3. | Biotech. 103 | 2+1 | 3. | Biotech.104 | 2+1 |
| 4. | Agron. 103 | 2+1 | 4. | Biotech.106 | 1+1 |
| 5. | Eng. 101 | 1+1 | 5. | PBG 201 | 2+1 |
| 6. | Env. 101 | 2+0 | 6. | CSE 101 | 1+2 |
| 7. | PBG 102 | 2+1 | 7. | Bio. 103 | 2+0 |
| 8. | FT 101 | 1+1 | 8. | Eng. 201 | 1+1 |
| 9. | HDFS 106 | 1+0 | 9. | Micro. 102 | 2+1 |
| 10. | **Pbi.101/<br>***Pbi. Cul. 101 | 0+2(NC)/<br>+0 (NC) | 10. | NCC\NSO/NSS | 0+1(nc) |
| 11. | NCC\NSO/NSS | 0+1(NC) | | | |
| | | 15+6/16+5=21+2NC+1NC=24 | | | 15+9/16+8=24+1NC=25 |

## SECOND YEAR

| | SEM I | | | SEM II | |
|---|---|---|---|---|---|
| 1. | Ent. Pl. Path. 203 | 2+1 | 1. | Biotech. 201 | 2+1 |
| 2. | Hort. 201 | 2+1 | 2. | Biotech. 203 | 2+1 |
| 3. | Bot. 201 | 2+1 | 3. | Biotech.204 | 2+1 |
| 4. | Econ. 201 | 2+1 | 4. | AS 201 | 2+1 |
| 5. | Math. 207 | 2+1 | 5. | Biochem. 207 | 3+1 |
| 6. | Micro. 201 | 2+1 | 6. | Mgt. 201 | 2+1 |
| 7. | Biotech. 202 | 2+1 | 7. | Phy. 202 | 2+1 |
| 8. | NCC/NSO/NSS | 0+1 (NC) | 8. | Stat. 206 | 1+1 |
| | | 14+7=21+1NC=22 | | NCC/NSO/NSS | 0+1 (NC) |
| | | | | | 16+8=24+1NC=25 |

## THIRD YEAR

| SEM I | | | SEM II | |
|---|---|---|---|---|
| | Biotech. 301 | 2+0 | Biotech. 306 | 2+1 |
| | Biotech. 302 | 2+0 | Biotech. 310 | 2+1 |
| | Biotech.303 | 2+0 | Biotech.311 | 2+1 |
| | Biotech.304 | 3+0 | Biotech.312 | 3+0 |
| | Biotech. 305 | 2+0 | Biotech. 313 | 2+2 |
| | PBG 301 | 1+1 | Biotech. 314 | 2+1 |
| | Biochem. 304 | 2+1 | PBG 302 | 1+1 |
| | Zoo. 312 | 2+1 | Stat. 302 | 2+1 |
| | Zoo. 313 | 3+1 | | 16+8=24 |
| | | 19+4=23 | | |

## FOURTH YEAR

| SEM I | | | SEM II | | |
|---|---|---|---|---|---|
| 1. | Biotech. 491 | 0+20 | 1. | Biotech. 493 | 10(0+10) |
| 2. | Biotech. 492 | 0+20 | 2. | Biotech. 494 | 10(0+10) |
| 3. | Edu Tour | 0+2 (NC) | | | 0+20=20 |
| | | 0+20+2NC=22 | | | |

A student will opt for only one module among the following:

1. Micropropagation
2. DNA Fingerprinting
3. Testing or Genetic Purity
4. Marker Assisted Selection
5. Haploid Production
6. Database Management

*Remedial Courses
** For students with domicile of Punjab who have not studies Punjabi at Matric/10+2 level

*** For students admitted through ICAR foreign students

**Summary Semester Wise Total Credit Hours**

| Sr. No. | Semester | Credit hours |
|---|---|---|
| 1. | Semester-I | 15+6/16+5=21+2NC+1NC=24 |
| 2. | Semester-II | 15+9/16+8=24+1NC=25 |
| 3. | Semester-III | 14+7=21=1NC=22 |
| 4. | Semester-IV | 16+8=24+1NC=25 |
| 5. | Semester-V | 19+4=23 |
| 6. | Semester-VI | 16+8=24 |
| 7. | Semester-VII | 0+20+2(NC)=22 |
| 8. | Semester-VIII | 0+20=20 |
| | Total | 177+2NC*+2NC**+4NC***=185 |

*Educational Tour
**Pbi 101/ PBI cUL. 101
*** NCC\NSS/NSO

# Course curriculum for 2 year Diploma in Agriculture

## CORE COURSES

### BASIC SCIENCES AND HUMANITIES

| | | | |
|---|---|---|---|
| 1. | Bot. 51 | Agricultural Botany | 1+1 |
| 2. | Econ 51 | Elementary Farm Management and Finance | 2+1 |
| 3. | Econ 52 | Marketing of Farm Products | 2+0 |
| 4. | Mgt. 51 | Agricusiness and Entreprencure Development | 2+1 |
| 5. | Micro 51 | Mushroom Cultivation | 1+1 |
| 6. | Zoo 51 | Fish Production | 1+1 |
| | | | 9+5=14 |

### COLLEGE OF AGRICULTURE

| | | | |
|---|---|---|---|
| 1. | Agron. 52 | Elementary Agronomy | 2+1 |
| 2. | Agron.53 | Crop Production –I | 2+1 |
| 3. | Agron.54 | Crop Production- II | 2+1 |
| 4. | Agromet. 51 | Elementary Agronomy | 1+1 |
| 5. | Biotech. 51 | Elementary Plant Tissue Culture | 1+1 |
| 6. | Ext.51 | Elementary Extension Education | 2+2 |
| 7. | Ent. 51 | Elementary Agriculture Entomology | 2+1 |
| 8. | Ent.52 | Useful Insects | 2+1 |
| 9. | Forst. 51 | Elementary Agroforestry | 1+1 |
| 10. | Flori. 51 | Landscaping and Floriculture | 1+1 |
| 11. | FT 51 | Elementary Food Technology | 1+1 |
| 12. | Hort. 51 | Elementary Fruit Cultivation | 2+1 |
| 13. | Hort. 52 | Nursery Production of Fruit Crops | 0+12 |
| 14. | PI. Path. 51 | Diseases of field Crops | 1+1 |
| 15. | PI. Path. 52 | Diseases of Fruit and Vegetable Crops | 1+1 |
| 16. | PBG 59 | Elementary Plant Breeding and Seed Production | 2+1 |
| 17. | LPM 51 | Elementary Livestock and Poultry Production | 3+1 |
| 18. | Soils 51 | Elementary soil Fertility | 2+1 |
| 19. | Soils 52 | Elementary Soil Physics and Conservation | 2+1 |
| 20. | Veg. 51 | Elementary Vegetable Cultivation | 2+1 |
| 21. | Veg.52 | Protected Cultivation of Vegetable Crops | 0+1 |
| | | | 32+22=54 |

### COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

| | | | |
|---|---|---|---|
| | FPM 51 | Farm Mechanization | 2+1 |
| | PFE 51 | Elementary Agro-Processing | 1+1 |
| | SWE 51 | Farm Irrigation and Drainage | 2+1 |
| | | | 5+3=8 |

# SEMESTER WISE STUDY PROGRAMME OF
# 2- Year Diploma in Agriculture

## FIRST YEAR

| | SEM I | | | SEM II | |
|---|---|---|---|---|---|
| 1. | Bot.51 | 1+1 | 1. | Agron. 54 | 2+1 |
| 2. | Agron. 52 | 2+1 | 2. | Hort. 52 | 0+1 |
| 3. | Agron. 53 | 2+1 | 3. | Soils 52 | 2+1 |
| 4. | Hort. 51 | 2+1 | 4. | FT 51 | 1+1 |
| 5. | Forst. 51 | 1+1 | 5. | Flori. 51 | 1+1 |
| 5. | Soils. 51 | 2+1 | 5. | Agromet. 51 | 1+1 |
| 6. | Veg. 51 | 2+1 | 6. | Econ. 51 | 2+1 |
| | | | 7. | FPM 51 | 2+1 |
| Total | | 12+7=19 | Total | | 11+7=19 |

## SECOND YEAR

| | SEM I | | | SEM II | |
|---|---|---|---|---|---|
| 1. | Mgt. 51 | 2+1 | 1. | PI. Path. 52 | 1+1 |
| 2. | Ent. 51 | 2+1 | 2. | Micro. 51 | 1+1 |
| 3. | PI. Path. 51 | 1+1 | 3. | Biotech. 51 | 1+1 |
| 4. | Econ. 52 | 2+0 | 4. | Et.52 | 2+1 |
| 5. | SWE 51 | 2+1 | 5. | LPM 51 | 3+1 |
| 5. | PFE 51 | 1+1 | 5. | Ext. 51 | 2+2 |
| 6. | PBG 59 | 2+1 | 6. | Veg. 52 | 0+1 |
| | | | 7. | Zoo. 51 | 2+1 |
| Total | | 12+6=18 | Total | | 12+9=21 |

Course curriculum for Diploma Course in Hybrid Seed Production Technology (Two Semesters) CORE COURSES

SECTION VIII

# FACULTY OF HORTICULTURE AND FORESTRY

- General Information
- Disciplines
- Fruit Science
- Vegetable Science
- Forestry and Natural resources
- Floriculture and Landscaping
- Course curriculum for B.Sc. (Hons.) Horticulture  4 year Programme

# COLLEGE OF HORTICULTURE AND FORESTRY

In the Punjab Agricultural University, the Department of Horticulture was established in December, 1962 with the inception of Punjab Agricultural University. In this department, research, teaching and extension activities were initiated in all the three disciplines horticulture, viz. Pomology, Olericulture and Floriculture. In addition to this three Regional Research Stations were established at Abohar, Bathinda, Gurdaspur, and two Fruit Research Stations were established at Bahadurgarh (Patiala) and Gangian (Hoshiarpur) to have the region based research on fruit crops.

The post-graduate courses in M.Sc. and Ph.D in Horticulture were started in 1962 and 1964, respectively in the Department of Horticulture. Subsequently, the Department of Vegetable Crops, Landscaping and Floriculture was carved out of the Department of Horticulture in 1974. A full-fledged Department of Floriculture and Landscaping was established in 1995.

The College of Horticulture and Forestry is located at the main campus of Punjab Agricultural University at Ludhiana, Punjab. The College was established in 2018, with its formal approval in the 287$^{th}$meeting of Board of Management held on 12th October 2018. This is the first and the only College in the state for imparting B.Sc. (Hons.) Horticulture. This College also imparts post graduate degrees i.e., M.Sc. in Horticulture in the discipline of Fruit Science, Vegetable Science, Floriculture & Landscaping and Forestry. The Ph.D Horticulture in the disciplines of Fruit Science, Vegetable Science and Floriculture & Landscaping is also awarded. The major mandate of the College is to strengthen teaching and research in Horticulture crops, forestry and also to develop human resources with a wider scope of employability.

Dr Manav Indra Singh Gill, then the Additional Director of Research (ADR), Horticulture and Food Science was given the additional charge of the new College as an Officer on Special Duty (OSD) in November 2018. The four departments namely Fruit Science, Vegetable Science, Floriculture & Landscaping and Forestry & Natural Resources earst while in College of Agriculture, PAU were transferred to this newly established college in April 2019. Dr Gill was then appointed Founder Dean of the College of Horticulture and Forestry on 28th August 2019, after University selection process through an open advertisement. The College undertakes teaching, research and extension activities in different disciplines of Horticulture. The overall goal of the College is to develop skilled human resources in Horticultural and allied fields, managing and using production resources to provide livelihood security to the rural people of Punjab and enhancing environmental security. Diversification in agriculture of Punjab is the key policy issue of state government and horticulture is one of the best options for enhancing farmers income per unit area and sustaining general agriculture in Punjab. This College aims to produce graduates, postgraduates having rich experience in horticulture. The College offers an undergraduate, Masters, Doctorate and two Diploma courses at main campuses of PAU as per details below

Apart from B.Sc. (Hons.) Horticulture 4year the college offers PG Courses viz M.Sc. Horticulture (Fruit Science), M.Sc. Horticulture (Vegetable Science), M.Sc. Horticulture (Floriculture & Landscaping), M.Sc. Forestry, Ph.D Horticulture (Fruit Science), Ph.D Horticulture (Vegetable Science) and Ph.D Floriculture & Landscaping; and diploma courses HSTC (Horticulture Supervisors Training Course), FLCC (Floriculture Landscaping Certificate Course).

The student evaluation criteria constitute internal and external components and a system of Credit Point Average on a 10 point-scale basis is followed for grading of students. The College has MoU for Ph.D Horticulture Student Exchange Programme with Dr YS Parmar University of Horticulture & Forestry and Collaborative research projects with overseas universities. The College of Horticulture and Forestry has developed many new high yielding varieties of horticultural crops with improved quality attributes and given several innovative production technologies which have been adopted by the farmers for efficient production in the state and country. The faculty of the College has distinguished itself to its contributions in the field of teaching, research and extension by winning several prestigious awards at national and International levels such as Padam Shri Award, Commonwealth Fellowship (UK) and Jawahar Lal Nehru Award etc.

# FRUIT SCIENCE

## PROGRAMMES

**M.Sc. Fruit Science**

**Ph.D Fruit Science**

## COURSE REQUIREMENTS

### M.Sc. FRUIT SCIENCE

| | |
|---|---|
| Field of Specialization | Fruit Breeding, Fruit Production, Horti.-Agro Techniques, Nursery Production, Orchard Management, Post-harvest Handling |
| Core Courses | FSC-501, FSC-502, FSC-503, FSC-504, FSC-506, FSC-507 |
| Minor Field | Agricultural Meteorology, Botany, Biochemistry, Biotechnology, Plant Breeding and Genetics, Plant Pathology-104, Soil and Water Engineering, Soil Science, Vegetable Science or any other as approved by Dean, Postgraduate Studies |
| Supporting Courses | Stat.-502 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D FRUIT SCIENCE

| | |
|---|---|
| Field of Specialization | Fruit Breeding, Fruit Production, Horti.-Agro Techniques, Nursery Production, Orchard Management, Post-harvest Handling |
| Core Courses | FSC-601, FSC-602, FSC-603 |
| Minor Field | Agricultural Meteorology, Botany, Biochemistry, Biotechnology, Plant Breeding and Genetics, Plant Pathology-104,Soil and Water Engineering, Soil Science, Vegetable Science or any other as approved by Dean, Postgraduate Studies |
| Supporting Courses | Courses as recommended by BSMA and from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Courses

**Hort. 51 Elementary Fruit Cultivation** **2+1** **Sem. I**

Fruits: importance, scope and their role in human nutrition. Fruit zones of Punjab. Planning, planting and after-care of fruit plants. Important hints (varieties, soil, irrigation, manuring and fertilization, weed management, training and pruning, harvesting, post harvest handling, insect-pest and diseases) for cultivation of fruit plants such as citrus, mango, pear, peach, plum, guava, grapes, litchi, loquat, ber, amla and papaya.

**Practical** : Identification of different fruit plants, layout, digging and filling of pits. Planting of young plants and protection from adverse weather conditions. Training and pruning, manuring and fertilization, and method of irrigation to different fruit plants, Identification and management of important diseases and pests of fruit plants.

**Hort. 52 Nursery Production of Fruit Crops** **0+1** **Sem. I**

Layout of a nursery, extraction and storage of healthy seeds, seed bed preparation, raising of rootstocks for different fruit plants, soil solarisation, preparation of potting mixtures, selection of healthy scion wood, practices in different methods of plant propagation like cuttings, layering, budding and grafting in fruit plants, management practices i.e. weed control, irrigation, nutrition, removal of sprouts etc, diagnosis and control of important diseases and pests in the nursery, lifting and packing of nursery plants.

## Undergraduate Courses

**Hort. 101 Elements of Fruit Science** **2+1** **Sem.I**

Scope and importance, classification of fruit crops and nutritive value, area and production, exportsand imports, fruit zones of India and Punjab, nursery techniques and their management, soil and climate, fruit nutrition garden – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit crops: Principles, objectives, types, and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in fruit crops-manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frames working, principles of organic farming, market chain management.

**Practical** : Features of orchard, planning and layout of orchard, tools and implements, identification of various fruit crops, layout of fruit nutrition garden, preparation of nursery beds and raising of rootstocks, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

**Hort. 102 Tropical Fruits** **2+1** **Sem.II**

Horticultural classification of fruits including genome classification. Horticultural zones of India. Area, production and export potential, varieties, climate and soil requirements, bearing habit, flowering and fruit set; propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, Plant growth regulators and their use in commercial orchards. Physiological disorders, special production problems, insect-pests, diseases and their control measures. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops:

Mango, banana, guava, papaya, sapota, anona, pineapple, jackfruit, avocado, mangosteen, carambola, durian, rambutan, bilimbi, rose apple, breadfruit and passion fruit. Sex expression, seed production and latex extraction and crude papain production and its economics.

**Practical** : Description and identification of varieties based on flower and fruit morphology in tropical fruits. Training and pruning of guava and mango. Selection of site and planting system, pre-treatment of suckers and desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Manure and fertilizer application including bio-fertilizers in fruit crops. Preparation and application of growth regulators. Ripening of fruits, grading and packaging. Production economics of tropical fruits. Visit to commercial orchards and diagnosis of maladies.

**Hort. 103 Fundamentals of Horticulture 1+1 Sem.I**

Horticulture-its definitions and branches, importance and scope; horticultural and botanical classification; climate and soil for horticultural crops; Plant propagation-methods and propagation structures; Seed dormancy, seed germination, principles of orchard establishment; Principles and methods of training and pruning, juvenility and flower bud differentiation; Unfruitfulness; Pollination, pollinizers and pollinators; Fertilization and parthenocarpy, Importance of plant bio-regulators in horticulture, irrigation-methods; Fertilizers application in horticultural crops.

**Practical** : Identification of garden tools. Identification of horticultural crops. Preparation of seed bed/ nursery bed. Practice of sexual and asexual methods of propagation including micro-propagation. Layout and planting of orchard. Training and pruning of fruit trees. Preparation of potting mixture. Fertilizers application in different crops. Visits to commercial nurseries/orchard.

**Hort. 104 Sub-Tropical Fruits and Plantation Crops 2+1 Sem.II**

Sub-Tropical Fruits Area, production and export potential, varieties, climate and soil requirements, bearing habit, flowering and fruit set. Propagation techniques, planting density and systems, aftercare, training and pruning. Management of water, nutrient and weeds. Plant growth regulators and their use in commercial orchards. Physiological disorders, special production problems, insect-pests, diseases and their control measures. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops: Citrus, grapes, pomegranate, litchi, ber, loquat, bael, amla, fig and date palm.

Plantation Crops

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization. Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation. Planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training and pruning, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders. Harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of following crops: coconut, arecanut, oilpalm, palmyrah palm, cacao, cashewnut, coffee, tea and rubber.

**Practical** : Description and identification of varieties based on flower and fruit morphology in sub-tropical fruits. Selection of site and planting system. Training and pruning. Manure and fertilizer application including bio-fertilizers in fruit crops. Preparation and application of growth regulators. Ripening of fruits, grading and packaging. Production economics of sub-tropical fruits. Visit to commercial orchards and diagnosis of maladies.

**Hort. 201 Production Technologies of Horticultural Crops 2+1 Sem. I**

Importance and scope of fruit, vegetable and flower crops. Classification and climatic requirements for cultivation of horticultural crops. Importance of fruits and vegetables for nutritional security. Selection of site, fencing, wind break, layout and planting systems for orchards. Sexual and asexual methods of plant propagation. Production technology of important fruit crops: Tropical- guava, mango, banana, papaya, pineapple and sapota; Sub-tropical-citrus, litchi, ber and grapes; Temperate - apple, pear, peach, plum, almond and walnut. Production technology of important vegetable crops-potato, peas, tomato, chilli, onion, brinjal, okra, cabbage, cauliflower, muskmelon, watermelon, cucumber, carrot, radish and leafy vegetables. Production technology of important flower crops-rose, chrysanthemum, gladiolus, marigold, gerbera, carnation, lillium, jasmine, anthurium and orchids.

**Practical** : Identification of important fruit, vegetable and flower crops. Layout and planning for planting orchards. Preparation of seed beds. Raising of seedlings, rootstocks. Propagation techniques of major fruit, vegetable and flower crops. Visit to commercial nurseries and orchards.

**Hort. 202 Production Technology for Fruit and Plantation Crops 1+1 Sem.II**

Horticulture-Definitions, Importance and scope of fruit and plantation crop industry in India, Selection of site, layout and planting methods, Training and pruning of fruit and plantation crops, Importance of rootstocks. Propagation methods. Production technologies for the cultivation of Major fruits -Mango, Banana, Citrus, Grape, Guava, Litchi Papaya , Sapota, Apple, Pear, Peach, Plum, Ber, Walnut and almond. Minor fruits- Date, Pineapple, Pomegranate, Jackfruit, Strawberry and Plantation Crops-Coconut, Arecanut, Cashew, Tea, Coffee and Rubber.

**Practical** : Horticultural tools and their uses. Containers and potting mixtures. Sexual and asexual methods of propagation, Scarification and stratification of seeds, Identification and description of fruits/ plantation crops, Layout and planting systems. Methods of training and pruning of commercial fruits, Preparation of plant bioregulators and their uses, Important pests, diseases and physiological disorders of fruit and plantation crops. Visit to local commercial orchards.

**Hort. 203 Principles of Horticultural Crops and Plant Protection 1+1 Sem.I**

Scope of horticulture. Soil and climatic requirements for fruit vegetable and floriculture crops, improved varieties of fruits, vegetables and flowers, site selection, layout and planting methods, nursery raising, sowing and planting time and methods, seed rate and seed treatment for vegetable crops. Macro propagation and micro propagation. Plant growing structures, pruning and training. Crop coefficients, water requirement, critical stages of irrigation and irrigation methods. Fertilizer application and fertigation, Harvesting, grading and packaging, post harvest practices. Garden tools. Management of orchard. Extraction and storage of vegetable seeds. Major pests and diseases and their management in horticultural crops.

**Practical** : Judging maturity time for harvesting of crop. Study of seed viability and germination test. Identification and description of important fruit, flower and vegetable crops. Study of different garden tools. Preparation of nursery bed. Practices of pruning and training in some important fruit crops. Visit to commercial greenhouse/polyhouse. Cultural operations for vegetable crops- sowing, fertilizer application, mulching, irrigation and weed control. Seed extraction techniques, identification of important pests and diseases and their control.

**Hort. 204 Temperate Fruits 2+1 Sem.II**

Classification of temperate fruits, Area, production and export potential, varieties, climate and soil requirements, propagation, planting density and systems, after care, training and pruning, self-incompatibility and pollinizers, use of growth regulators, nutrient, water and weed management, physiological disorders, special production problems, insect pests and diseases and their control measures, post-harvest handling, harvest indices, harvesting, grading, packaging and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queensland nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, alternate bearing and their remedies.

**Practical** : Description and identification of varieties based on flower and fruit morphology. Manuring and fertilization including bio-fertilizers, planting systems, propagation and nursery management practices, preparation and use of growth regulators, training and pruning in temperate crops. Visit to private orchards and diagnosis of maladies. Economics of temperate fruits.

**Hort. 205 Plant Propagation and Nursery Management 2+1 Sem.I**

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy, types of dormancy, internal and external factors. Nursery management, apomixes – mono-embryony, polyembrony, chimera & bud sport. Propagation structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements), use of growth regulators in seed germination, types and

stages of seed germination and vegetative propagation, methods and techniques of division, cutting, layering, grafting, formation of graft union, factor affecting healing of graftage and budding. Physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation, hardening of plants in nurseries. Nursery registration act. Insect/ pest/disease control in nursery, Cost of establishment of propagation structures.

**Practical** : Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, graftings and buddings, use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery.

**Hort. 206 Breeding of Fruit Crops** **1+1** **Sem.II**

Fruit breeding - history, importance in fruit production. Breeding objectives for improvement of commercial fruits, their distribution, domestication and adaptation. Variability for economic traits. Breeding strategies. Clonal selection, bud mutations, mutagenesis and its application in crop improvement – policy manipulations - *in vitro* breeding tools in important fruit crops. Breeding for insect-pest & disease resistance and abiotic stresses. Plant genetic resources, their conservation and utilization.

**Practical** : Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like mango, banana, citrus, grapes, guava, sapota, papaya, custard apple, aonla, ber, litchi, pomegranate, jamun, apple, pear, plum, peach and strawberry.

**Hort. 207 Post-harvest Physiology of Horticultural Produce** **2+1** **Sem.I**

Definition and scope of post-harvest physiology. Estimates of postharvest losses and their impact on market economy. Pre-harvest factors and production practices influencing post-harvest performance. Physiological maturity indices for harvesting. Principal causes of post-harvest losses: Physiological changes during produce deterioration and their control, mechanical damage (physical injury). Types of fresh produce and their post-harvest physiology. Respiration; post-harvest water loss, the concept of water potential, and VPD. Climacteric and non-climacteric fruits. The effect of ethylene on post-harvest shelf life of produce. Loss of nutrients and other compositional parameters during storage. Postharvest disorders viz; chilling injury, high temperature stress, water stress. Practices to enhance post-harvest storability, retention of quality in fresh fruits and vegetables, cut flowers and ornamentals. Harvesting, post-harvest handling. Importance of packaging, selection of packaging for fresh produce, packaging materials. Cold storage and refrigerated transport.

**Practical** : Preparation of standard solutions; methods of measuring water status in plant tissue; measurement of respiration rate; environmental factors influencing post-harvest losses; measurement of quality parameters; physiological maturity indices, effect of plant hormones in delaying leaf senescence, ripening and shelf life of fruits and vegetables. Measurement of product quality: Composition--sugars, acids, nutrients, aroma volatiles, colour, texture, taste. Demonstrations and hands on activities on storage practices and quality Characteristics.

**Hort. 301 Post- harvest Management and Value addition of Fruits & Vegetable** **1+1** **Sem. I**

Importance of post-harvest management and processing of fruits and vegetables, extent and possible causes of post-harvest losses; Pre and Post-harvest factors affecting storage life and quality. Maturity, ripening and changes occurring during ripening; Harvesting, grading, pre-cooling, packing and transport, Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods

of preservation; Concepts and standards of intermediate moisture food - jam, jelly, marmalade, preserve, candy; tomato products, drying/ dehydration of fruits & vegetables, osmotic drying and canning. Fermented and non-fermented beverages, packaging of products.

**Practical** : Identification of equipment used in post-harvest handling. Applications of different types of packaging, containers for enhancing shelf life. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Preparation of jam, jelly, marmalade, RTS, nectar, squash, osmotically dried products, fruit bar, candy, tomato and canned products. Quality evaluation of products - physico-chemical and sensory. Visit to processing unit/ industry.

**Hort. 302 Hi-tech Horticulture** **2+1** **Sem.II**

Introduction and importance, Containerized nursery production and mechanization, Micro-propagation of horticultural crops, Field preparation and improved planting methods, Protected cultivation-advantages, controlled conditions, methods and techniques, Micro-irrigation systems and their components, Fertigation EC and pH-based fertilizer scheduling, Canopy management, high density planting, Components of precision farming-remote sensing, Geographical Information System (GIS), Differential Geo-positioning System (DGPS), Variable Rate Applicators (VRA), Application of precision farming in fruit, vegetables and ornamental crops, Mechanized harvesting.

**Practical** : Types of polyhouses and shade net houses, Intercultural operations, Tools and equipment-identification and application, Micro-propagation, Nursery pro-trays, Micro-irrigation, Fertigation- EC and Ph based fertilizer scheduling, Canopy management, Visit to hi-tech orchard/nursery.

**Hort. 303 Postharvest Management of Horticultural Crops** **2+1** **Sem.I**

Importance of postharvest technology in horticultural crops. Maturity indices, harvesting, handling, grading of fruits, vegetables and cut flowers. Pre-harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and bio-chemical changes, hardening and delaying ripening process. Postharvest treatments of horticultural crops. Quality parameters and specifications. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Physiological disorders-causes and prevention. Methods of storage for local market and export. Pre-harvest treatment and pre-cooling, pre-storage treatments. Different systems of storage, packaging methods and types of packages, recent advances in packaging, Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport for local, distant and export market, cold chain. Specifications/quarantine requirements of fruits and vegetables for export, Ripening technologies, Layout of packhouse.

**Practical** : Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Visit to markets, packing houses and cold storage units.

**Hort. 304 Dryland Horticulture** **2+1** **Sem.II**

**(In collaboration with Department of Soil Science)**

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands. Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc. Techniques and management of dry land horticulture. Water shed development, soil and water conservation methods-terraces, contour bunds etc. Methods of control and impounding of run-off water - farm ponds, trenches, macro catch pits etc. In-situ water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, anti transpirants, growth regulators, etc. water use efficiency -need based, economic and conjunctive use of water, micro systems of irrigation etc. Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, in-situ grafting, deep pitting/planting, canopy management etc. Characters and special adaptation of crops: ber, aonla,

annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

**Practical** : Study of rainfall patterns. Contour bunding/trenching, micro catchments rainfall erosivity and soil erodibility indices, measurement of runoff, soil loss and their control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Morphological and anatomical features of drought tolerant fruit crops.

**Hort. 305 Fundamentals of Growth and Development of Horticultural Crops 2+1 Sem.I**

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalization and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climacteric and non-climacteric fruits. Physiology of fruits under post-harvest storage.

**Practical** : Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables; seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

**Hort. 306 Orchard and Estate Management 1+1 Sem.II**

Orchard &estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural cropping systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards and topworking. Frame working. Integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of horticultural crops.

**Practical** : Layout of different systems of orchard and estate, soil management, clean, inter, cover and mixed cropping, fillers. Use of mulch materials, organic and inorganic, moisture conservation, weeds control. Layout of various irrigation systems.

## POSTGRADUATE COURSES

### M.Sc. Courses

**FSC-501 Tropical Fruit Production 2+1 Sem.I**

**Unit I** Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco physiological requirements

**Unit II** Propagation, Planting and Orchard Floor Management :Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio fertilizers, role of bio-regulators, biotic and abiotic factors limiting fruit production.

**Unit III** Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders - causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques, marketing, Agri export zones and industrial support; insect and disease management.

**CROPS**

Mango, Banana, Guava, Sapota, Pineapple ,Papaya, Avocado, Jackfruit, Annonas, Aonla and Ber.

**Practical** : Distinguished features of tropical fruit species, cultivars and root stocks. Demonstration of planting systems, training and pruning. Handson practices on pollination and cropregulation. Leaf sampling and nutrient analysis. Physiological disorders - maladydiagnosis. Physico-chemical analysis of fruit quality attributes. Field/Exposure visits to tropical orchards. Project preparation forest abolishing commercial orchards.

**FSC-502 Sub-Tropical and Temperate Fruit Production 2+1 Sem.II**

**Unit I** Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, ecophysiological requirements.

**Unit II** Propagation, Planting and Orchard Floor Management: Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

**Unit III** Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques, marketing, Agri export zones and industrial support; insect and disease management.

**CROPS**

Citrus, Grapes, Litchi, Loquat, Jamun, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond and Pecan.

**Practical** : Distinguished features of fruit species, cultivars and root stocks. Demonstration of planting systems, training and pruning. Handson practices on pollination and crop regulation. Leaf sampling and nutrient analysis. Physiological disorders-malady diagnosis. Physico-chemical analysis of fruit quality attributes. Field/Exposure visits to subtropical and temperate orchards. Project preparation forest abolishing commercial orchards.

**FSC-503 Propagation and Nursery Management of Fruit Crops 2+1 Sem.I**

**Unit I** General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

**Unit II** Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mistand hotbeds. Use of PGR inpropagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship - graft incompatibility, physiology of rootstock and top working.

**Unit III** Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.

**Unit IV** Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.

**Practical** : Handson practices on rooting of dormant and summer cuttings. Anatomical studies in rooting of cutting and graft union. Hands-on practices on various methods of budding and grafting. Propagation

by layering and stooling. Micropropagation-explant preparation, media preparation, culturing–meristem tip culture, axillary bud culture, micro-grafting, hardening. Visit to commercial tissue culture laboratories and accredited nurseries.

**FSC-504 Breeding of Fruit Crops** **2+1** **Sem.II**

**Unit I** Importance, Taxonomy and Genetic Resources: Introduction and importance, origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources.

**Unit II** Blossom Biology and Breeding Systems: Blossom biology, breeding systems –spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes.

**Unit III** Conventional and Non-Conventional Breeding: Approaches for crop improvement –direct introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrusts.

**CROPS**

Mango,Banana,Pineapple,Citrus,Grapes,Litchi,Guava,Pomegranate,Papaya,Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts

**Practical** : Exercises on bearing habit, floralbiology. Pollenvi ability and fertility studies. Handson practice sinhybridization. Raising and handling of hybrid progenies. Induction of mutations and polyploidy. Evaluation of biometrical traits and quality traits. Screening for resistance against abioticstresses. Developing breeding programme for specific traits.Visit research stations working on fruitbreeding.

**FSC-505 Systematics of Fruit Crops** **2+1** **Sem.II**

**Unit I** Nomenclature and Classification: Biosystematics – introduction and significance ; history of nomenclature of cultivated plants, classification and nomenclature systems ; International code of nomenclature for cultivated plants

**Unit II** Identification and Description: Methods of identification and description of cultivated fruit and nut species and their wild relatives features; development of plant keys for systematic identification and classification. Fruit crop descriptors- based upon Bioversity International Descriptors and UPOV/DUS test guidelines, botanical and pomological description of major cultivars and rootstocks of tropical, subtropical and temperate fruits and nut crops

**Unit III** Registration and Modern Systematics: Registration, Use of Chemotaxonomy, biochemical and molecular markers in modern systematics

**Practical** : Exercises on identification and pomological description of various fruits pecies and cultivars. Development of descriptive blanks *vis-à-vis* UPOV/DUS test guidelines and Bioversity International. Descriptors for developing fruit species and cultivar descriptive databases. Visits to major germplasm centres and field gene banks.

**FSC-506 Canopy Management in Fruit Crops** **1+1** **Sem.II**

**Unit I** Introduction, Types and Classification: Canopy management-importance and factors affecting canopy development. Canopy types and structures, canopy manipulation for optimum utilization of light and its interception. Spacing and utilization of land area-Canopy classification.

**Unit II** Physical Manipulation and Growth Regulation: Canopy management through rootstock, scion, plant growth regulators, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality in major fruit crops.

**Practical** : Study of different types of canopies. Training of plants for different canopy types. Canopy development through pruning. Understanding bearing behavior and canopy management indifferent fruits. Use of plant growth regulators. Geometry of planting. Development of effective canopy with support system. Study on effect of different canopy types on production and quality of fruits.

**FSC-507 Growth and Development of Fruit Crops** **2+1** **Sem.I**

**(In collaboration with Department of Botany)**

**Unit I** General Concepts and Principles: Growth and development-definition, parameters of growth and development, growth dynamics and morphogenesis.

**Unit II** Climatic Factors, Hormones and Developmental Physiology: Environmental impact on growth and development- effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat units and the moperiodism. Assimilate partitioning, influence of water and mineral nutrition in growth and development, concepts of plant hormone and bioregulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brasssinosteroids, other New PGRs. Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

**Unit III** Strategies for Overcoming Stress: Growth and developmental process during stress -manipulation of growth and development, impact of pruning and training, chemical manipulations and Commercial application of PGRs in fruit crops, molecular and genetic approaches in plant growth and development.

**Practical** : Understanding dormancy mechanism sin fruit crops and seed stratification. Techniques of growth analysis. Evaluation of photosyn the ticefficiency under different environments. Exercises on hormone eassays. Practicals on use of growth regulators. Understanding ripening phenomenon in fruits. Study on impact of physical manipulations on growth and development. Study on chemical manipulations on growth and development. Understanding stress impact on growth and development.

**FSC-508 Nutrition of Fruit Crops** **2+1** **Sem.I**

**(In collaboration with Department of Soil Science)**

**Unit I** General Concepts and Principles: Importance and history of nutrition in fruit crops, Role of essential plant nutrients, factors affecting plant nutrition; nutrient uptake and their removal from soil.

**Unit II** Diagnostics, Estimation and Application: Nutrient requirements, root distribution in fruitcrops,soil and foliar application of nutrients in major fruit crops, fertilizer use efficiency. Methods and techniques for evaluating the requirement of macro- and micro-elements, Diagnostic and interpretation techniques including DRIS. Role of different macro-and micro-nutrients, their deficiency and toxicity disorders, corrective measures to overcome deficiency and toxicity disorders.

**Unit III** Integrated Nutrient Management (INM): Fertigation in fruit crops, bio-fertilizers and their use in INM systems.

**Practical** : Visual identification of nutrient deficiency symptom sin fruit crops. Identification

And application of organic, in organic and bio-fertilizers. Soil/tissue collection and preparation for macro- and micro-nutrient analysis. Analysis of soil physical and chemical properties- pH,EC, Organic carbon. Determination of N,P,K and other macro-and micro nutrients. Fertigation in glass house and field grown horticultural crops. Preparation of micro-nutrient solutions, their spray and soil applications.

**FSC-509 Biotechnology of Fruit Crops** **2+1** **Sem.II**

**Unit I** Introduction, History and Basic Principles: Introduction and significance, history and basic principles, influence of explants material, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture

**Unit II** *In vitro* Culture and Hardening: Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture. Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues. Hardening and *ex vitro* establishment of tissue cultured plants

**Unit III** *In vitro* Breeding, Trans genics and Gene Technologies: Somatic cell hybridisation, construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization,

haploids, *in vitro* mutation, artificial seeds, cryopreservation, *In vitro* selection for biotic and abiotic stress. Genetic engineering-principles and methods, trans genics in fruit crops, use of molecular markers and genomics. Genesilencing, genetagging, gene editing, achievements of biotechnology in fruit crops.

**Practical** : An exposure to lowcost, commercial and home stead tissue culture laboratories. Media preparation, Inoculation of explants for clonal propagation, call us induction and culture, regeneration of plantlets from callus. Sub-culturing techniques on anther, ovule, embryoculture, somaclonal variation. *Invitro*mutant selection against abiotic stress. Protoplast culture and fusion technique. Development of protocols for mass multiplication. Project development for establishment of commercial tissue culture laboratory.

**FSC-510 Organic Fruit Culture** **2+1** **Sem.I**

**(In collaboration with School of Organic Farming)**

**Unit I** Principles and Current Scenario: Organic horticulture, scope, area, production and world trade, definition, principles, methods and SWOT analysis.

**Unit II** Farming System and Practices: Organic farming systems including biodynamic farming, naturalfarming, homaorganic farming, rishi krishi, EMtechnology, cosmicfarming; on-farm and off-farm production of organic inputs, role of bio-fertilizers, bio enhancers, legumes, inter cropping, cover crops, green manuring, zero tillage, mulching and their role in organic nutrition management. Organic seed sand planting materials, soil health management in organic production, weed management practices in organic farming, biological management of pests and diseases, trap crops, quality improvement in organic production of fruit crops.

**Unit III** Inspection, Control Measures and Certification: Inspection and certification of organic produce, participatory guarantee system (PGS), NPOP, documentation and control, development of internal control system (ICS), Concept of group certification, constitution of grower group as per NPOP, preparation of ICS manual, internal and external inspection, concept of third party verification, certification of small farmer groups (Group Certification),transaction certificate, group certificate, critical control points (CCP) and HACCP, IFOAM guidelines on certification scope and chain of custody, certification trademark – The Logo, accredited certification bodies under NPOP. Constraints in certification, IFOAM and global scenario of organic movement, postharvest management of organic produce. Economics of organic fruit production.

**Practical** : Design of organic orchards/farms management. Conversion plan. Nutrient management and microbial assessment of composts and bio-enhancers. Preparation and application of composts ,bio-enhancers and bio-pesticides. Organic nursery raising. Application of composts, bio-enhancers, bio-fertilizers and bio-pesticides, green manure, cover ,mulching. Preparation and use of neem based products. Biodynamic preparations and their role in organic agriculture, EM technology and products, biological/ natural management of pests and diseases. Soil solarisation. Framework for GAP. Documentation for certification.

**FSC-511 Export Oriented Fruit Production** **2+1** **Sem.II**

**Unit I** Statistics and World Trade: National and international fruit export and import scenario and trends; Statistics and India's position and potentiality in world trade; export promotion zones in India. Government Policies.

**Unit II** Policies, Norms and Standards: Scope, produce specifications, quality and safety standards for export of fruits *viz*., mango, banana, grape, litchi, pomegranate, walnut, apple and other important fruits. Processed and value-added products, post harvest management for export including packaging and cool chain; HACCP, Codex alimentarius, ISO certification; WTO and its implications, sanitary and phyto-sanitary measures.

**Unit III** Infrastructure and Plant Material: Quality fruit production under protected environment; different types of structures – Automated greenhouses, glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures. Seed and planting material; meeting export standards, implications of plant variety protection – patent regimes.

**Practical** : Export promotion zones and exports cenario of fresh fruits and their products. Practical exercises on quality standards of fruits for export purpose. Quality standards of planting material and seeds. Hi-tech nursery in fruits. Practicals on ISO specifications and HACCP for export of fruits. Sanitary and phyto-sanitary measures during export of horticultural produce. Postharvest management chain of horticultural produce for exports. Visit to export oriented units/agencies like APEDA, NHB, etc.

**FSC-512 Climate Change and Fruit Crops** **1+0** **Sem.II**

**(In collaboration with Climate Change & Agricultural Meteorology)**

**Unit I** Introduction, Global Warming and Climatic Variability: Introduction to climate change. Factors affecting climate change. Global warming, effect of climate change on spatio-temporal patterns of temperature and rain fall, Greenhouse gas emission. pollution levels such as tropospheric ozone, change in climatic variability and extreme events.

**Unit II** Impact Assessment and Mitigation: Sensors for recording climatic parameters, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, longer growing seasons and shifts in plant hardiness for fruit crops. Climate mitigation measures through crop management- use of tolerant rootstocks and varieties, mulching-use of plastic-windbreak- spectral changes- protection from frost and heat waves. Climate management in greenhouse- heating - vents - $CO^2$ injection - screens –artificial light. Impact of climate changes on invasive insect, disease, weed, fruit yield, quality and sustainability. Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems.

**Unit III** Response to Climate Change: Case studies – responses of fruit trees to climatic variability *vis-a-vis* tolerance and adaptation, role of fruit tree in carbon sequestration.

**FSC-513 Minor Fruit Production** **2+1** **Sem.I**

**Unit I** Occurrence, Adoption and General Account: Importance – occurrence and distribution, climate adaptation in fragile ecosystem, degraded soils and wastelands.

**Unit II** Propagation and Cultural Practices: Traditional cultural practices and recent development inagro-techniques; propagation, botany-floral biology, growth patterns, mode of pollination, fruit set, ripening, fruit quality.

**Unit III** Post-Harvest Management: Postharvest management, marketing; minor fruit crops in terms of medicinal and antioxidant values ; their uses for edible purpose and in processing industry

**CROPS**

Bael, chironji, fig, passion fruit, jamun, phalsa, karonda, woodapple, Cactus pear, khejri, kair, pilu, lasoda, loquat, tamarind, dragon fruit, monkey jack, mahua, khirni, amra, kokum, cape gooseberry, kaphal, persimmon, pistachio, seabuckthorn, hazel nut and Other minor fruits of regional importance

**Practical** : Visits to institutes located in the hot and cold arid regions of the country. Identification of minor fruits plants/cultivars. Collection of leaves and preparation of herbarium. Allelopathic studies. Generating know-how on reproductive biology of minor fruits. Fruit quality attributes and biochemical analysis. Project formulation for establishing commercial orchards in fragile ecosystems.

**FSC-591 Seminar** **1+0**

**FSC-599 Master's Research** **0+30**

## Ph.D Courses

**FSC-601 Innovative Approaches in Fruit Breeding** **3+0** **Sem. II**

**Unit I** Current Trends and Status: Modern trends in fruit breeding –with major emphasis on precocity, low tree volume, suitability for mechanization, health benefits etc.

**Unit II** Inheritance Patterns and Breeding Systems: Genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits.

**Unit III** Plant Architecture, Stress Tolerance and Fruit Quality: Recent advances in crop improvement - wider adaptation, plant architecture, amenability to mechanization, fruit quality attributes, stress tolerance, crop specific traits; use of apomixis, geneintrogression and wide hybridization ( alien genes).

**Unit IV** Transgenics, Markers and Genomics: Molecular and transgenic approaches in improvement of selected fruit crops fast track breeding – marker assisted selection and breeding (MAS and MAB), use of genomics and gene editing technologies.

**CROPS**

Mango, banana, guava, papaya, Citrus, grapes, pomegranate, litchi, apple, pear, strawberry, kiwifruit, plums, peaches, apricot, cherries, nectarines, nut crops.

**FSC-602 Modern Trends in Fruit Production 3+0 Sem.II**

**Unit I** General Concepts and Current Scenario: National and International scenario, national problems.

**Unit II** Propagation, Planting Systems and Crop Regulation: Recent advances inpropagation -rootstocks, planting systems, High density planting, crop modeling, Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation.

**Unit III** Overcoming Stress and Integrated Approaches: Effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Physiological disorders, Total quality management (TQM) - Current topics.

**CROPS**

Mango, Banana, Grapes, Citrus, Papaya, Litchi, Guava, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherry, Almond, Walnut, Pecan, Strawberry, Kiwifruit.

**FSC-603 Recent Developments in Growth Regulation 3+0 Sem.I**

**Unit I** Current Concepts and Principles: Eco-physiological influences on growth and development of fruit crops-flowering, fruit set- Crop load and assimilate partitioning and distribution.

**Unit II** Phytohormones and Growth Regulators: Root and canopy regulation, study of plant growth regulators in fruit culture-structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phytohormones– internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

**Unit III** Regulation of Developmental Processes: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.

Flower drop and thinning, fruit-set and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation- current topics.

**FSC-604 Advanced Laboratory Techniques 1+2 Sem.I**

**Unit I** Safety Measures and Laboratory Maintenance: Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solutions, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.

**Unit II** Destructive and Non-destructive Analysis Methods: Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, and starch in food crops.

**Unit III** Chromatographic and Microscopic Analysis: Basic chromate graphic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra filtration. Application of nuclear techniques inharvested produces. Advance dmicroscopic techniques, on leakage as an index of member an eperme ability, determination of biochemical components in horticultural produce.

**Unit IV** Sensory Analysis Importance of ethylene, quantitative estimation frate of ethyleneevolution, using gaschromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.

**Practical** : Determination of moisture, relative water content and physiological loss in weight. Determination of biochemical components in horticultural produce. Calibration and standardization of instruments. Textural properties of harvested produce. Determination of starch index (SI). Specific gravity for determination of maturity assessment, and pH of produce. Detection of adulterations in fresh as well as processed products. Non-destructive determination of colour, ascorbic acid, vitamins, carotenoids, sugars and starch. Estimation of rate of ethylene evolution using gaschro matograph (GC).Use of advanced microscopes (fluorescent, scanning electron microscope, phase contrast, etc.)

**FSC-605 Arid and Dryland Fruit Production 2+0 Sem.II**

**Unit I** General Concepts and Current Scenario: Characteristics features and major constraints of the arid and dry land region, distinguishing features of the fruit species trees for adaptation in adapting to the region, nutritional and pharmaceutical importance, national problems.

**Unit II** Propagation, Planting Systems and Crop Regulation: Recent advances in propagation- root stocks, planting systems, High density planting, crop modelling, Precision farming, decision support systems-aspects of crop regulation-physical and chemical regulation, effects on physiology and development, influence of stress factors.

**Unit III** Stress Mitigation and Integrated Approaches: Strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, total quality management (TQM)-Current topics.

**Unit IV** Aonla, Annonas, ber, bael, jamun, date palm, cactus pear, khejri, kair, pilu, lasoda, manila, tamarind, monkey jack, mahua, khirni, amra, seabuckthorn, chilgoza, cafel, rhododendron, box myrtle, chironji, phalsa, karonda, woodapple, paniala and other minor fruits of regional importance.

**FSC-606 Abiotic Stress Management in Fruit Crops 2+1 Sem.I**

**Unit I** Basic Aspects and Principles: Stress – definition, classification, stresses due to water (high and low),temperature (high and low),radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).Pollution - increased level of $CO_2$, industrial wastes, impact of stress in fruit crop production, stress indices, physiological and biochemical factors associated with stress, fruit crops suitable for different stress situations.

**Unit II** Assessment, Physiology and Performance: Crop modeling for stress situations, cropping systems, assessing the stress through remote sensing, understand in adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity.

**Unit III** Mitigation Measures and Conservation Practices: Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, stability and sustainability indices.

**Practica**l : Seed treatment/ hardening practices. Container seedling production. Analysis of soil moisture estimates (FC,ASM,PWP). Analysis of plant stress factors, RWC, chlorophyll flourosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations. Biological efficiencies, WUE, solar energy conversion and efficiency. Crop growth sustainability indices and economics of stress management. Visit to orchards and watershed location.

**FSC-607 Biodiversity and Conservation of Fruit Crops 2+1 Sem.II**

**Unit I** Issues, Goals and Current Status: Biodiversity and conservation; issues and goals-needs and challenges; present status of gene centres; world's major centres of fruit crop domestication; current status of germplasm availability/database of fruit crops in India

**Unit II** Collection, Maintenance and Characterization: Exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections.

Germplasm conservation- *in situ* and *ex situ* strategies, on farm conservation; problem of recalcitrancy-cold storage of scions, tissue culture, cryopreservation, pollen and seed storage.

**Unit III** Germplasm Exchange, Quarantine and Intellectual Property Rights: Regulatory horticulture, inventory and exchange of fruit and nut germplasm, plant quarantine, phytosanitary certification, detection of genetic constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPV&FR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged fruit varieties in India

**Practical** : Documentation of germplasm-maintenance of passport data and other records of accessions. Field exploration trips and sampling procedures. Exercise on *ex situ* conservation–cold storage, pollen/ seed storage. Cryopreservation. Visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of Germplasm. Germplasm characterization using a standardized DUS test protocol. Special tests with biochemical and molecular markers.

**FSC-608 Smart Fruit Production** **2+0** **Sem.I**

**Unit I** Importance and Overview: Introduction and importance; concepts and applications of artificial intelligence systems; case studies in horticulture

**Unit II** GIS, Sensors and Wireless Systems: Application of sensors in fruit production, crop monitoring – crop load and stress incidence forecast modules, remote sensing, Geographical Information System (GIS), Differential Geo-Positioning System (DGPS) hi-tech nursery production of fruit crops under protected conditions ,ultra modern wireless based drip irrigation network,

**Unit III** Concepts and Methods: Nanotechnology for smart nutrient delivery in fruit farming, concepts and methods, practical utility, nano-fertilizers, nano-herbicides; nano-pesticides

**Unit IV** Mechanization, Automation and Robotics: Production systems amenable to automation and mechanization; automated protected structures (turn-key systems); hydroponics, aeroponics, bioreactors for large scale plant multiplication; Use of drones and robotics in fruit growing – robotic planters, sprayers, shakers, harvesters, stackers etc. Visit to Hi-tech facilities.

**FSC-691 Seminar I** **1+0**

**FSC-692 Seminar II** **1+0**

**FSC-699 Ph.D Research** **0+75**

# VEGETABLE SCIENCE

## PROGRAMMES

**M.Sc. Vegetable Science**

**Ph.D Vegetable Science**

## COURSER EQUIREMENTS

### M.Sc. VEGETABLE SCIENCE

| | |
|---|---|
| Field of Specialization | Vegetable Breeding, Vegetable Production, Post-harvest Handling |
| Core Courses | VSC-501, VSC-502, VSC-503, VSC-504, VSC-510 |
| Minor Field | Plant Breeding and Genetics, Biotechnology, Botany, Biochemistry, Agronomy, Fruit Science, Soil Science, Soil and Water Engineering, Farm Machinery and Power Engineering, Processing and Food Engineering, Plant Pathology-104, Forestry, Food Science & Technology, Biochemistry or any other as approved by Dean, Postgraduate studies |
| Supporting Courses | Stat.-502 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D VEGETABLE SCIENCE

| | |
|---|---|
| Field of Specialization | Vegetable Breeding, Vegetable Production, Post-harvest Handling |
| Core Courses | VSC-601, VSC-602 |
| Minor Field | Plant Breeding and Genetics, Biotechnology, Botany, Agronomy, Fruit Science, Soil Science, Soil and Water Engineering, Farm Machinery and Power Engineering, Processing and Food Engineering, Plant Pathology-104, Forestry, Food Science & Technology, Biochemistry or any other as approved by Dean, Postgraduate studies. |
| Supporting Courses | Courses as recommended by BSMA and from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Deficiency Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 and Stat.-502 |

# DESCRIPTION OF COURSE CONTENTS

## Diploma Courses

**Veg. 51 Elementary Vegetable Cultivation** **2+1** **Sem. I**

Role of vegetables in human nutrition and agricultural economy. Types of vegetable gardens including home garden, market garden, truck garden, seed garden and processing garden. Roof top cultivation. Production practices of winter season vegetable crops i.e. potato, cole crops (cabbage, cauliflower, knolkhol, broccoli), root crops (radish, carrot, turnip, beetroot), bulb crops (onion, garlic), garden peas, lettuce, palak, methi, and summer season vegetable crops i.e. tomato, brinjal, chilli, sweet pepper, okra, beans (cowpeas, French bean, cluster bean), sweet potato and amaranthus.

**Practical** : Identification of vegetable seeds and crops. Nursery raising. Layout of kitchen garden. Sowing methods of potato, cucurbitaceous and leafy vegetables. Fertilization, irrigation, plant protection measures and weed management. Off-season vegetable production.

**Veg. 52 Protected Cultivation of Vegetable Crops** **0+1** **Sem. II**

Importance, scope, future prospectus of protected cultivation. Types of protected structures and their fabrication. Media for protected cultivation. Low tunnel technology. Green house production of tomato, capsicum and cucumber. Training and pruning. Bulb set technique in onion. Hybrid seed production of vegetables. Drip irrigation, fertigation and mulching in vegetables.

## Undergraduate Courses

**Veg. 101 Tropical and Sub-tropical Vegetable Crops** **2+1** **Sem. II**

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Classification of vegetable crops and Types of vegetable gardens. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical and sub-tropical vegetable crops such as tomato, brinjal, okra, chillies, capsicum, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, basella.

**Practical** : Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), Layout of Kitchen Garden.

**Veg. 201 Temperate Vegetable Crops** **2+1** **Sem. I**

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing of cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, lettuce, palak, chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, asparagus, vegetable kale.

**Practical** : Identification and description of cool season vegetable crops, propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

**Veg. 202 Production Technology for Vegetables and Spices** **1+1** **Sem. II**

Importance of vegetables & spices in human nutrition and national economy, kitchen gardening, origin, area, climate, soil, improved varieties of regional importance and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting, yield and important physiological disorders of vegetable and spices (Tomato, Brinjal, Chilli, Capsicum, Cucumber, Melons, Gourds, Pumpkin, French bean, Peas, Okra; Cole crops - Cabbage, Cauliflower, Knol-khol; Bulb crops-Onion, Garlic; Root crops - Carrot, Radish, Beetroot; Tuber crops - Potato; Leafy vegetables - Amaranth, Palak; Perennial vegetables.

**Practical** : Identification of vegetable and spice crops, Identification of vegetable and spice crop seeds, Bed preparation and method of nursery sowing, Raising of cucurbit seedlings for early cultivation, Direct sowing of cucurbits, Planning and layout of kitchen garden, Transplanting of vegetable seedlings, Method of fertilizer application and calculation of different fertilizer doses, Intercultural operations in vegetable crops, Harvesting, grading and packaging of vegetable crops, Seed extraction of cucurbit vegetables, Economics of vegetable spice cultivation.

**Veg. 204 Breeding of Vegetable, Tuber and Spice Crops** **2+1** **Sem. II**

Breeding objectives and important concepts of breeding of self-pollinated, cross-pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, disease resistance, abiotic stress resistance, male sterility, self-incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops: Tomato, Brinjal, Capsicum, Chilli, Cucurbits, Pea, Beans, Cabbage, Cauliflower, Okra, Potato, Tuber crops, Carrot, Radish, Spice crops (Ginger, Turmeric). Breeding procedures for development of hybrids/varieties in various crops. Genetic basis of adoptability and stability.

**Practical** : Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability, heterosis, heterobeltosis, standard heterosis, G x E interactions (stability analysis), Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

**Veg. 301Vegetable Breeding** **2+1** **Sem. II**

Definition and history of vegetable breeding. Origin, distribution, wild relatives and breeding objective of different vegetable crops viz. tomato, brinjal, chilli, muskmelon, watermelon, cucumber, bitter gourd, pumpkin, squashes, onion, garlic, carrot, radish, cauliflower, cabbage, pea, okra and potato. Plant genetic resources, their utilization and conservation. Breeding procedures of self-pollinated, often cross pollinated, cross-pollinated and vegetatively propagated vegetable crops. Conventional and modern techniques for improvement of vegetable crops. Breeding for stress tolerance and quality in vegetable crops. Genetic mechanisms for exploitation of heterosis in vegetable crops.

**Practical** : Study of inflorescence and flower structures. Practice for emasculation and artificial pollination. Distinguished morphological characteristics of released varieties/hybrids. Layout of field experiments. Estimation of genetic advance and heritability. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods. Visit to vegetable seed production field.

**Veg. 302 Protected Cultivation** **2+1** **Sem. II**

**(In collaboration with Department of Floriculture and Landscaping)**

Protected cultivation- importance, scope and constraints, status of protected cultivation in India and world. Soil/substrate preparation and management. Types of benches and containers. Irrigation and fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops viz., tomato, bell pepper, cucumber, brinjal, rose, carnation, chrysanthemum, gerbera, lilium, pot plants, etc. Off season production of flowers and vegetables. Insect pest and disease management.

**Practical** : Identification of different protected structure, Use of Protrays in quality planting material production, Identification of different growing media/ substrates, Raising of seedlings and saplings under protected cultivation, Bed preparation, planting and intercultural operations for crop production, Estimation and management of soil EC, Estimation and management of pH in media/ substrates, Scheduling of irrigation in different horticultural crops, Fertilizer management through drip irrigation in horticultural crops, Control of disease and insect pests in protected structures, Visit to commercial protected units.

**Veg. 304 Seed Production of Vegetable, Tuber and Spice Crops 2+1 Sem. II**

Introduction and history of seed industry in India. Definition of seed, classes-types of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction, grading and storage, packaging and labelling of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. seed priming and pelleting, Field and seed standards. Seed drying and extraction. Seed legislation.

**Practical** : Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

**Veg. 305 Production Technology of Tuber Crops 1+1 Sem. I**

Origin, area, production, economic importance and export potential, description of varieties and hybrids, climate and soil requirement, season, seed rate, preparation of field, planting practices, spacing, water, nutrient and weed management, nutrient deficiencies, use of chemicals and growth regulators, cropping systems, harvesting practices, yield, post- harvest handling and storage, field and seed standards, marketing,seed plot technique, true potato seed and economics of cultivation of potato and tropical, sub-tropical and temperate tuber crops. Crops to be covered – potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke.

**Practical** : Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing. Working out cost of cultivation, project preparation of commercial cultivation.

**Veg. 491 Agro-industrial Attachment 0+4 Sem. I**

The students opting for this module under 491 series courses under Agro-industrial Attachment will be attached for hands on training at either of the following locations:

Commercial Vegetable Nurseries

Farms of Progressive Vegetable Growers

Vegetable Processing Plants

**Veg. 492 Experiential Learning Programme 0+20 Sem.II**

The students opting for this module under Experiential Learning module (Commercial Vegetable Production) shall raise the vegetable(s) following the recommended PAU package of practices for vegetable crops.

## POSTGRADUATE COURSES

### M.Sc. Courses

**VSC-501 Production of Cool Season Vegetable Crops** **2+1** **Sem. I**

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/hybrids, seed rate and seed treatment, raising of nursery, sowing/planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of crops.

**Unit I** Bulb and tuber crops- Onion, garlic and potato

**Unit II** Cole crops- Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale

**Unit III** Root crops- Carrot, radish, turnip and beetroot

**Unit IV** Peas and beans- Garden peas and broad bean

**Unit V** Leafy vegetables- beet leaf, fenugreek, coriander and lettuce

**Practical** : Scientific raising of nursery and seed treatment; Sowing and transplanting; Description of commercial varieties and hybrids; Demonstration on methods of irrigation, fertilizers and micronutrients application; Mulching practices, weed management; Use of plant growth substances in cool season vegetable crops; Study of nutritional and physiological disorders; Studies on hydroponics, aeroponics and other soilless culture; Identification of important pest and diseases and their control; Preparation of cropping scheme for commercial farms; Quality evaluation for carotene, protein and ascorbic acid; Visit to commercial farm, greenhouse/polyhouses; Visit to vegetable market; Analysis of benefit to cost ratio.

**VSC-502 Production of Warm Season Vegetable Crops** **2+1** **Sem. II**

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/hybrids, seed rate and seed treatment, raising of nursery including grafting technique, sowing/planting time and methods, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices namely hydroponics, aeroponics, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marking), pest and disease management and economics of crops.

**Unit I** Fruit vegetables- Tomato, brinjal, hot pepper, sweet pepper and okra.

**Unit II** Beans- French bean, Indian bean (Sem), cluster bean and cowpea.

**Unit III** Cucurbits- Cucumber, melons, gourds, pumpkin and squashes.

**Unit IV** Tuber crops- Sweet potato, elephant foot yam, tapioca, taro and yam.

**Unit V** Leafy vegetables- Amaranth and drumstick.

**Practical** : Scientific raising of nursery and seed treatment; Sowing, transplanting, vegetable grafting; Description of commercial varieties and hybrids; Demonstration on methods of irrigation, fertilizers and micronutrients application; Mulching practices, weed management; Use of plant growth substances in warm season vegetable crops; Study of nutritional and physiological disorders; Studies on hydroponics, aeroponics and other soilless culture; Identification of important pest and diseases and their control; Preparation of cropping scheme for commercial farms; Quality determination for sugar, capsaicin and minerals using atomic absorption; Visit to commercial farm, greenhouse/polyhouses; Visit to vegetable market; Analysis of benefit to cost ratio.

**VSC-503 Growth and Development of Vegetable Crops** **2+1** **Sem. II**

**Unit I** Introduction and phytohormones- Definition of growth and development; Cellular structures and their functions; Physiology of phyto-hormones functioning/biosynthesis and mode of action; Growth analysis and its importance in vegetable production

**Unit II** Physiology of dormancy and germination- Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production

**Unit III** Abiotic factors- Impact of light, temperature, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops; Apical dominance

**Unit IV** Fruit physiology- Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening

**Unit V** Morphogenesis and tissue culture- Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops

**Practical** : Preparation of plant growth regulator's solutions and their application; Experiments in breaking and induction of dormancy by chemicals; Induction of parthenocarpy and fruit ripening; Application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables; Growth analysis techniques in vegetable crops; Grafting techniques in tomato, brinjal, cucumber and sweet pepper.

**VSC-504 Principles of Vegetable Breeding** **2+1** **Sem. I**

**Unit I** Importance and history- Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding

**Unit II** Selection procedures- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE)

**Unit III** Heterosis breeding- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms

**Unit IV** Mutation and Polyploidy breeding; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment

**Unit V** Ideotype breeding- Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of In vitro and molecular techniques in vegetable improvement

**Practical** : Floral biology and pollination behaviour of different vegetables; Techniques of selfing and crossing of different vegetables viz., Cole crops, okra, cucurbits, tomato, eggplant, hot pepper, etc; Breeding system, development and handling of filial generations of different vegetables, Selection indices in vegetable crops; Estimation of heritability, heterosis and combining ability; Hybrid seed production of vegetable crops; Exposure to biotechnological lab practices; Visit to breeding farms.

**VSC-505 Breeding of Self-Pollinated Vegetable Crops** **2+1** **Sem. II**

Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act.

**Unit I** Tuber crops: Potato.

**Unit II** Fruit vegetables- Tomato, eggplant, hot pepper, sweet pepper and okra.

**Unit III** Leguminous vegetables- Garden peas and cowpea.

**Unit IV** Leguminous vegetables: French bean, Indian bean, cluster bean and broad bean.

**Unit V** Leafy vegetables- Lettuce and fenugreek.

**Practical** : Floral mechanisms favouring self and often cross pollination; Progeny testing and development of inbred lines; Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; Palynological studies, selfing and crossing techniques; Hybrid seed production of vegetable crops; Screening techniques for biotic and abiotic stress resistance in above mentioned crops; Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques; Visit to breeding farms.

**VSC-506 Breeding of Cross-Pollinated Vegetable Crops 2+1 Sem. I**

Origin, botany, taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding, and QTLs, PPV and FR act

**Unit I** Cucurbitaceous crops- Gourds, melons, cucumber, pumpkin and squashes.

**Unit II** Cole crops- Cauliflower, cabbage, kohlrabi, broccoli and brussels sprouts.

**Unit III** Root and bulb crops- Carrot, radish, turnip, beet root and onion.

**Unit IV** Tuber crops- Sweet potato, tapioca, taro and yam.

**Unit V** Leafy vegetables- Beet leaf, spinach, amaranth and coriander.

**Practical** : Floral mechanisms favouring cross pollination; Development of inbred lines; Selection of desirable plants from breeding population; Observations and analysis of various quantitative and qualitative traits in germplasm, hybrids and segregating generations; Induction of flowering, palynological studies, selfing and crossing techniques; Hybrid seed production of vegetable crops in bulk; Screening techniques for biotic and abiotic stress resistance in above mentioned crops; Demonstration of sib-mating and mixed population; Molecular marker techniques to identify useful traits in vegetable crops and special breeding techniques; Visit to breeding blocks.

**VSC-507 Protected Cultivation of Vegetable Crops 2+1 Sem. II**

**Unit I** Scope and importance- Concept, scope and importance of protected cultivation of vegetable crops Principles, design, orientation of structure, low and high cost polyhouses/greenhouse structures

**Unit II** Types of protected structure- Classification and types of protected structures/ greenhouse/ polyhouses, plastic-non plastic low tunnels, plastic walk in tunnels, high roof tunnels with ventilation, insect proof net houses, shed net houses, rain shelters, NVP, climate control greenhouses, hydroponics and aeroponics; Soil and soilless media for bed preparation; Design and installation of drip irrigation and fertigation system.

**Unit III** Abiotic factors- Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables.

**Unit IV** Nursery raising- High tech vegetable nursery raising in protected structures using plugs and portrays, different media for growing nursery under protected cultivation; Nursery problems and management technologies including fertigation.

**Unit V** Cultivation of crops- Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures.

**Unit VI** Solutions to problems- Problems of growing vegetables in protected structures and their remedies, physiological disorders, insect and disease management in protected structures; Use of protected structures for seed production; Economics of greenhouse crop production.

**Practical** : Study of various types of protected structure; Study of different methods to control temperature, carbon dioxide and light; Study of different types of growing media, training and pruning systems in greenhouse crops; Study of fertigation and nutrient management under protected structures; Study of insect pests and diseases in greenhouse and its control; Use of protected structures in hybrid seed production of vegetables; Economics of protected cultivation (Any one crop); Visit to established green/ polyhouses/shade net houses in the region.

**VSC-508 Seed Production of Vegetable Crops** **2+1** **Sem. II**

**Unit I** Introduction, history, propagation and reproduction- Introduction, definition of seed and its quality, seed morphology, development and maturation; Apomixis and fertilization; Modes of propagation and reproductive behaviour; Pollination mechanisms and sex forms in vegetables; History of vegetable seed production; Status and share of vegetable seeds in seed industry.

**Unit II** Agro-climate and methods of seed production- Agro-climate and its influence on quality seed production; Deterioration of crop varieties, genetical and agronomic principles of vegetable seed production; Methods of seed production, hybrid seeds and techniques of large scale hybrid seed production; Seed village concept.

**Unit III** Seed multiplication and its quality maintenance- Seed multiplication ratios and replacement rates in vegetables; Generation system of seed multiplication; Maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds; Seed quality and mechanisms of genetic purity testing.

**Unit IV** Seed harvesting, extraction and its processing- Maturity standards; Seed harvesting, curing and extraction; Seed processing viz., cleaning, drying and treatment of seeds, seed health and quality enhancement, seed priming, seed pelleting, packaging and marketing; Principles of seed storage; Orthodox and recalcitrant seeds; Seed dormancy.

**Unit V** Improved agro-techniques and field and seed standards- Improved agro-techniques; Field and seed standards in important solanaceous, leguminous and cucurbitaceous vegetables, cole crops, leafy vegetables, bulbous and root crops and okra; clonal propagation and multiplication in vegetative propagated crops; Seed plot technique and true potato seed production in potato.

**Practical** : Study of floral biology and pollination mechanisms in vegetables; Determination of modes of pollination; Field and seed standards; Use of pollination control mechanisms in hybrid seed production of important vegetables; Maturity standards and seed extraction methods; Seed sampling and testing; Visit to commercial seed production areas; Visit to seed processing plant; Visit to seed testing laboratories.

**VSC-509 Production of Underutilized Vegetable Crops** **2+1** **Sem. I**

Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post harvest management of:

**Unit I** Stem and bulb crops- Asparagus, leek and Chinese chive.

**Unit II** Cole and salad crops- Red cabbage, Chinese cabbage, kale, sweet corn and babycorn.

**Unit III** Leafy vegetables- Celery, parsley, Indian spinach (poi), spinach, chenopods, chekurmarin and indigenous vegetables of regional importance.

**Unit IV** Gourds and melons- Sweet gourd, spine gourd, teasle gourd, round gourd, Ivy gourd, snake gourd, pointed gourd, kachri, long melon, snap melon and gherkin.

**Unit V** Yam and beans- Elephant foot yam, yam, yam bean, lima bean and winged bean.

**Practical** : Identification and botanical description of plants and varieties; Seed/planting material; Production, lay out and method of planting; Important cultural operations; Identification of important pests and diseases and their control; Maturity standards and harvesting; Visit to local farms.

**VSC-510 Systematics of Vegetable Crops** **1+1** **Sem. I**

**Unit I** Significance of systematic- Significance of systematics and crop diversity invegetable crops; Principles of classification; different methods of classification; Salient features of international code of nomenclature of vegetable crops.

**Unit II** Origin and evolution- Origin, history, evolution and distribution of vegetable crops (Solanaceous, cucurbitaceous, cole, legumes, okra, bulb, root crops).

**Unit III** Botanical and morphological description- Botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Morphological keys to identify important families, floral biology, floral formula and diagram; Morphological description of all parts of vegetables.

**Unit IV** Cytology- Cytological level of various vegetable crops with descriptive keys.

**Unit V** Molecular markers- Importance of molecular markers in evolution of vegetable crops; Molecular markers as an aid in characterization and taxonomy of vegetable crops.

**Practical** : Identification, description, classification and maintenance of vegetable species and varieties; Survey, collection of allied species and genera locally available; Morphological keys to identify important families, floral biology, floral formula and diagram; Preparation of keys to the species and varieties; Methods of preparation of herbarium and specimens, Molecular Techniques in characterization and taxonomy of vegetable crops.

**VSC-511 Organic Vegetable Production** **1+1** **Sem. II**

**Unit I** Importance and principles- Importance, principles, perspective, concepts and components of organic farming in vegetable crops.

**Unit II** Organic production of vegetables- Organic production of vegetable crops viz., solanaceous, cucurbitaceous, cole, bulb, root and tuber crops, legumes and okra.

**Unit III** Managing soil fertility- Managing soil fertility, mulching, raising green manure crops, weed management in organic farming system; Crop rotation in organic production; Processing and quality control of organic vegetable produce.

**Unit IV** Composting methods- Indigenous methods of composting, Panchyagavvya, Biodynamics preparations and their application; ITKs in organic vegetable farming; Role of botanicals and bio-control agents in the management of pests and diseases in vegetable crops.

**Unit V** Certification and export- Techniques of natural vegetable farming, GAP and GMP certification of organic products; Export- opportunity and challenges

**Practical** : Methods of preparation and use of compost, vermicompost, biofertilizers and biopesticides; Soil solarisation; Use of green manures; Waste management; Organic soil amendments in organic production of vegetable crops; Weed, pest and disease management in organic vegetable production; Visit to organic fields and marketing centres.

**VSC-512 Production of Spice Crops** **2+1** **Sem. I**

Introduction and importance of spice crops- historical accent, present status (national and international), future prospects, botany and taxonomy, climatic and soil requirement, commercial cultivars/hybrids, site selection, layout, sowing/planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, postharvest management, plant protection measures, quality control and pharmaceutical significance of crops mentioned below:

**Unit I** Fruit spices- Black pepper, small cardamom, large cardamom and allspice.

**Unit II** Bud and kernel- Clove and nutmeg.

**Unit III** Underground spices- Turmeric, ginger and garlic.

**Unit IV** Seed spices- Coriander, fenugreek, cumin, fennel, ajowain, dill and celery.

**Unit V** Tree spices- Cinnamon, tamarind, garcinia and vanilla.

**Practical** : Identification of seeds and plants; Botanical description of plant; Preparation of spice herbarium; Propagation; Nursery raising; Field layout and method of planting; Cultural practices; Harvesting, drying, storage, packaging and processing; Value addition; Short term experiments on spice crops.

**VSC-513 Processing of Vegetable Crops** **1+1** **Sem. I**

**Unit I** Present status- Present status and future prospects of vegetable preservation industry in India.

**Unit II** Spoilage and biochemical changes- Spoilage of fresh and processed vegetable produce; biochemical changes and enzymes associated with spoilage of vegetable produce; Principal spoilage organisms, food poisoning and their control measures; Role of microorganisms in food preservation.

**Unit III** Processing equipments- Raw material for processing; Primary and minimal processing; Processing equipments; Layout and establishment of processing industry; FPO licence; Importance of hygiene; Plant sanitation.

**Unit IV** Quality control- Quality assurance and quality control, TQM, GMP; Food standards- FPO, PFA, etc.; Food laws and regulations; Food safety- hazard analysis and critical control points (HACCP); Labeling and labeling act and nutrition labeling.

**Unit V** Value addition- Major value added vegetable products; Utilization of by products of vegetable processing industry; Management of processing industry waste; Investment analysis; Principles and methods of sensory evaluation of fresh and processed vegetables.

**Practical** : Study of machinery and equipments used in processing of vegetable produce; Chemical analysis for nutritive value of fresh and processed vegetable; Study of different types of spoilage in fresh as well as processed vegetable produce; Classification and identification of spoilage organisms; Study of biochemical changes and enzymes associated with spoilage; Laboratory examination of vegetable products; Sensory evaluation of fresh and processed vegetables; Study of food standards- National, international, CODEX Alimentarius; Visit to processing units to study the layout, hygiene, sanitation and waste management.

**VSC-514 Postharvest Management of Vegetable Crops** **2+1** **Sem. II**

**Unit I** Importance and scope- Importance and scope of post-harvest management of vegetables.

**Unit II** Maturity indices and biochemistry- Maturity indices and standards for different vegetables; Methods of maturity determination; Biochemistry of maturity and ripening; Enzymatic and textural changes; Ethylene evolution and ethylene management; Respiration and transpiration along with their regulation methods.

**Unit III** Harvesting and losses factors- Harvesting tools and practices for specific market requirement; Postharvest physical and biochemical changes; Preharvest practices and other factors affecting postharvest losses.

**Unit IV** Packinghouse operations- Packing house operations; Commodity pre-treatments chemicals, wax coating, precooling and irradiation; Packaging of vegetables, prevention from infestation, management of postharvest diseases and principles of transportation.

**Unit V** Methods of storage- Ventilated, refrigerated, modified atmosphere and controlled atmosphere storage, hypobaric storage and cold storage; Zero-energy cool chamber, storage disorders like chilling injury in vegetables.

**Practical** : Studies on stages and maturing indices; Ripening of commercially important vegetable crops; Studies of harvesting, pre-cooling, pre-treatments, physiological disorders- chilling injury; Improved packaging; Use of chemicals for ripening and enhancing shelf life of vegetables; Physiological loss in weight, estimation of transpiration, respiration rate and ethylene release; Storage of important vegetables; Cold chain management; Visit to commercial packinghouse, cold storage and control atmosphere storage.

**VSC-591 Seminar** **1+0**

**VSC-599 Master's Research** **0+30**

## Ph.D Courses

**VSC-601 Recent Trends in Vegetable Production** **3+0** **Sem. I**

Present status and prospects of vegetable cultivation; nutritional, antioxidant and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; Hi-tech nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies/disorders and correction methods; different cropping systems; mulching; Protected cultivation of vegetables, containerized culture for year round vegetable production; low cost polyhouse; net-house production; crop modelling, organic gardening; vegetable production for pigments, export and processing of:

**Unit I** Solanaceous crops: Tomato, brinjal, chilli, sweet pepper.

**Unit II** Cole crops: Cabbage, cauliflower and knol-khol, sprouting broccoli.

**Unit III** Okra, onion, peas and beans, amaranth and drumstick.

**Unit IV** Root crops and cucurbits: Carrot, beet root, turnip and radish and cucurbits.

**Unit V** Tuber crops: Potato, Sweet potato, Cassava, elephant foot yam, Dioscorea and taro.

**VSC-602 Advances in Breeding of Vegetable Crops** **3+0** **Sem. II**

Evolution, distribution, cytogenetics, Genetics and genetic resources, wild relatives, genetic divergence, hybridization, inheritance of qualitative and quantitative traits, heterosis breeding, plant ideotype concept and selection indices, breeding mechanisms, pre breeding, mutation breeding, ploidy breeding, breeding for biotic and abiotic stresses, breeding techniques for improving quality and processing characters, bio-fortification, in vitro breeding, marker assisted breeding, DH breeding, development of transgenic, Genome editing.

**Unit I** Solanaceous crops - Tomato, Brinjal, Hot Peeper, Sweet Pepper.

**Unit II** Cucurbits, Cole crops and Okra.

**Unit III** Legumes and leafy vegetables - Peas and Beans, Amaranth, Palak, Chenopods and Lettuce.

**Unit IV** Root and bulb crops- Carrot, Beetroot, Radish, Turnip, Onion, Garlic.

**Unit V** Tuber crops –Potato, Sweet potato, Tapioca, Elephant foot yam, Colocasia, Dioscorea.

**VSC-603 Abiotic Stress Management in Vegetable Crops** **2+1** **Sem. II**

**Unit I** Environmental stress - its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress.

**Unit II** Mechanism and measurements - tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

**Unit III** Soil-plant-water relations - under different stress conditions in vegetable crops production and their management practices.

**Unit IV** Agronomic and breeding strategies for growing vegetables under water deficit, water logging, salinity and sodicity.

**Unit V** Use of chemicals - techniques of vegetable growing under high and low temperature conditions, use of chemicals, anti transpirants and grafting in alleviation of different stresses.

**Practical** : Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops; measurement of tolerance to various stresses in vegetable crops; short term experiments on growing vegetable under water deficit, water logging, salinity and sodicity, high and low temperature conditions; Use of chemicals for alleviation of different stresses.

**VSC-604 Seed Certification, Processing and Storage of Vegetable Crops 2+1 Sem. I**

**Unit I** Seed certification, history, concepts and objectives, seed certification agency, phases of seed certification, Indian Minimum seed Certification standards, Planning and management of seed certification programmes.

**Unit II** Principles and procedures of field inspection, seed sampling, testing and granting certification, OECD certification Schemes.

**Unit III** Principles of seed processing, Methods of seed drying and cleaning, seed processing plant-Layout and design, seed treatment, seed quality enhancement, packaging andmarketing.

**Unit IV** Principles of Seed Storage, orthodox/ recalcitrant seeds, types of storage (open, bulk, controlled, germplasm, cryopreservation), factors affecting seed longevity in storage (Pre and post harvest factors).

**Unit V** Seed aging and deterioration, maintenance of seed viability and vigour during storage, storage methods, storage structures, transportation and marketing of seeds.

**Practical** : General procedures of seed certification; Field inspection and standards; Isolation and rouging; Inspection and sampling at harvesting, threshing and processing; Testing physical purity, germination and moisture, grow-out test; Visit to regulatory seed testing and plant quarantine laboratories; Seed processing plants and commercial seed stores.

**VSC-605 Breeding for Special Traits in Vegetable Crops 2+0 Sem. II**

Important nutrient constituents in vegetables and their role in human diet. Genetics of nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategies for developing varieties with improved nutrition for market and industrial purposes. Molecular and biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and colour content

**Unit I** Brassica group, carrot and beetroot.

**Unit II** Tomato, brinjal, peppers and potato.

**Unit III** Green leafy vegetables, Legume crops and okra.

**Unit IV** Cucurbitaceous vegetable crops and edible Alliums.

**Unit V** Biofortification in vegetable crops, genetic engineering for improvement of quality traits in vegetable crops, bioavailability of dietary nutrients from improved vegetable crops and impact on micronutrient malnutrition, achievements and future prospects in breeding for quality traits in vegetables.

**VSC-606 Biodiversity and Conservation of Vegetable Crops 2+1 Sem. I**

**Unit I** General aspects: issues, goals and current status: Biodiversity and conservation; issues and goals- needs and challenges; present status of gene centres; world's major centres of vegetable crop domestication; current status of germplasm availability/database of vegetable crops in India.

**Unit II** Germplasm conservation: collection, maintenance and characterization: Exploration and collection of germplasm; sampling frequencies; size and forms of vegetable germplasm collections; active and base collections. Germplasm conservation- in situ and ex situ strategies, on farm conservation; problem of recalcitrance- tissue culture, cryopreservation, pollen and seed storage.

**Unit III** Regulatory horticulture: Germplasm exchange, quarantine and intellectual property rights germplasm exchange, quarantine and intellectual property rights regulatory horticulture, inventory and exchange of vegetable germplasm, plant quarantine, phytosanitary certification, detection of genetic constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPV and FR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged vegetable varieties in India.

**Practical** : Documentation of germplasm- maintenance of passport data and other records of accessions; Field exploration trips and sampling procedures; Exercise on ex situ conservation – cold storage, pollen/ seed storage; Cryopreservation; Visits to national gene bank and other centers of PGR activities; Detection of genetic constitution of germplasm; Germplasm characterization using a standardised DUS test protocol; Special tests with biochemical and molecular markers.

**VSC-607 Biotechnological Approaches in Vegetable Crops** **2+1** **Sem. II**

**Unit I** Importance and scope of biotechnology - in vegetable crop improvement. In vitro culture, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, endosperm culture.

**Unit II** Somatic embryogenesis - somaclonal variation and synthetic seed production, protoplast isolation, culture, manipulation and fusion. Somatic hybrids and cybrids and their application in vegetable improvement programme.

**Unit III** Blotting techniques, DNA finger printing - Molecular markers/DNA based markers and role. RFLP, AFLP, RAPD, SSR, SNPs, DNA probes. QTL mapping. MAS and its application in vegetable crop improvement. Allele mining by TILLING and Eco-TILLING.

**Unit IV** Plant genetic engineering - Scope and importance, Concepts of cisgenesis, intragenesis and transgenesis. Gene cloning, direct and indirect methods of gene transfer. Role of RNAi based gene silencing in vegetable crop improvement. Bio-safety issue, regulatory issues for commercial approval.

**Unit V** Concepts and methods of next generation sequencing (NGS)- Genome sequencing, transcriptomics, proteomics, metabolomics. Genome editing (ZFN, TALENS and CRISPER) Crops Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables.

**Practical** : Micropropagation, Pollen- Ovule and Embryo culture- Synthetic seed production; In vitro mutation induction, in vitro rooting – hardening at primary and secondary nurseries; DNA isolation from economic vegetable crop varieties – Quantification and amplification DNA and Protein profiling – molecular markers, PCR Handling; Vectors for cloning and particle bombardment; DNA fingerprinting of Vegetable crop varieties; Project preparation for establishment of low, medium and high cost tissue culture laboratories.

**VSC-608 Advanced Laboratory Techniques for Vegetable Crops** **1+2** **Sem. II**

**Unit I** Safety measures and laboratory maintenance - Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solutions, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.

**Unit II** Destructive and non-destructive analysis methods - Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, starch in vegetable crops.

**Unit III** Chromatographic and microscopic analysis- basic chromatographic techniques, GC, HPLC, Electrophoresis techniques. Application of nuclear techniques in vegetable produce. Advanced microscopic techniques, ion leakage as an index of membrane permeability, determination of biochemical components in vegetables.

**Practical** : Determination of moisture, relative water content and physiological loss in weight; Determination of biochemical components (sugars (reducing and non-reducing), protein, capsaicin, ascorbic acid, titrable acidity, phenols, O-dihyodroxy phenols, carotene and pigments, dry matter, colour, lycopene, colouring matter, texture, oleoresin content, TSS, flavonols) in vegetables; Calibration and standardization of instruments; Textural properties of harvested produce; Determination of starch index (SI); Specific gravity for determination of maturity assessment, and pH of produce; Detection of adulterations in fresh as well as processed products; Non-destructive determination of colour, ascorbic acid, vitamins, carotenoids, sugars and starch; Estimation of rate of ethylene evolution using gas chromatograph (GC); Use of advanced microscopes (fluorescent, scanning electron microscope, phase contrast, etc.); chromatography including TLC, GLC, column chromatography; Electrophoresis, PCR and isolation of plant DNA.

**VSC-691 Seminar I** **1+0**

**VSC-692 Seminar II** **1+0**

**VSC-699 Ph.D Research** **0+75**

# FLORICULTURE & LANDSCAPING

## PROGRAMMES

**1. M. Sc. Floriculture and Landscaping**

**2. Ph. D Floriculture and Landscaping**

## COURSE REQUIREMENT

**M. Sc. Floriculture and Landscaping**

| | |
|---|---|
| Field of Specialization | Floriculture and Landscaping |
| Core Courses | FLS-501, FLS-502, FLS-503, FLS-504, FLS-505 |
| Minor Field | Biotechnology, Botany, Forestry, Fruit Science, Plant Breeding & Genetics, Vegetable Science, Soil Science or any other as approved by Dean, Postgraduate Studies. |
| Supporting Courses | Stat.-502, other supporting courses could be selected from discipline not related to the major discipline. It could be any discipline considered relevant for student's research work or necessary for building his/her overall competence. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

**Ph. D (Hort.) Floriculture and Landscaping**

| | |
|---|---|
| Field of Specialization | Floriculture and Landscaping |
| Core Courses | FLS-601, FLS-602, FLS-605 |
| Minor Field | Biotechnology, Botany, Forestry, Fruit Science, Plant Breeding & Genetics, Vegetable Science, Soil Science or any other as approved by Dean, Postgraduate Studies. |
| Supporting Courses | Supporting courses could be selected from discipline not related to the major discipline. It could be any discipline considered relevant for student's research work or necessary for building his/her overall competence. |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENT

**Under Graduate Courses**

**Flori. 101 Ornamental Horticulture** **1+1** **Sem. I**

Definitions, scope of ornamental horticulture. Importance, classification and general cultivation aspects for ornamental plants *viz*. Annuals, biennales herbaceous perennials and bulbous ornamentals. Shrubs, climbers, trees, indoor plants, palms and cycads, ferns, cacti and succulents, Importance, design and establishment of garden features/components viz. hedge, edge, borders, topiary, flower beds, bridges, paths, driveway, fences, garden walls, gates, arbour, patio, retaining walls, sunken garden, roof garden, terrace garden, rockery, water garden and children park. Establishment and maintenance of lawn. Importance of garden adornments viz. floral clock, bird bath, statutes, sculptures, lanterns, water basins, garden benches etc. Uses of vertical garden, terrariums. Bonsai making and maintenance.

**Practical :** Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns, cycads and palms. Planning, designing and establishment of garden features viz. lawn, hedge and edge, rockery, water garden, roof garden. Study and creation of terrariums, vertical garden, Making and maintenance of bonsai. Visit to nurseries and floriculture units.

**Flori. 102 Principles of Landscape Architecture** **1+1** **Sem. II**

Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, Steps in preparation of garden design. Use of Auto CAD in designing gardens. Factors affecting landscape design viz. initial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. Axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc. Elements of landscape gardens. Bio-aesthetic planning, definition, objectives, Planning and designing of home gardens, colonies, countryside planning, urban landscape, Development of institutional gardens, planning and planting of avenues, beautifying schools, railway stations, factories, bus stands, air ports corporate buildings, dams, river banks, play grounds, Gardens for places of religious importance, Importance, features and establishment of English garden , Japanese gardens , Mughal, gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens, Xeriscaping, definition, principles and practice.

**Practical :** Study of gardens, tools and implements. Use of drawing equipments, graphic symbols and notations in landscaping designing, Study and designing of different styles of gardens, Study and designing of gardens based on different themes, Designing gardens using Auto-cad, Designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, religious places, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and National highways, Design and establishment of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

**Flori. 201 Commercial Floriculture** **2+1** **Sem. I**

Scope and importance of commercial floriculture in India, production techniques of commercial flower crops like rose, marigold, chrysanthemum, orchid, carnation, jasmine, crossandra, anthurium, dahlia, bird of paradise, china aster and gerbera for domestic and export market, Production techniques for bulbous crops viz. gladiolus, lilium, tuberose etc., Production techniques of flowers and foliage filler materials. Growing of flowers under protected environments such as glass house, plastic house etc., Industrial importance of ornamental plants and flowers. Importance of flower arrangement, techniques, types, suitable flowers and cut foliage. Postharvest technology of cut flowers in respect of commercial flower crops, dehydration technique for drying of flowers.

**Practical :** Identification of commercially important floricultural crops. Propagation and cultural practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Study and practice of different types of flower arrangements,

preparation of floral bouquets, preparation of floral rangoli, veni etc., Drying and preservation of flowers. Flower arrangement practices.

**Flori. 202 Production Technology for Ornamental Crops and Landscaping 1+1 Sem. II**

Importance and scope of ornamental plants and landscaping. Art principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers- rose, gerbera, carnation, lilium and orchids under protected conditions and gladiolus, tuberose, chrysanthemum under open conditions. Package of practices for loose flowers - marigold and jasmine. Processing and value addition in ornamental crops.

**Practical :** Identification of ornamental plants. Nursery bed preparation and seed sowing. Training and pruning of ornamental plants. Planning and layout of garden. Protected structures – care and maintenance. Intercultural operations in flowers. Harvesting and post harvest handling of cut and loose flowers. Visit to commercial flower unit.

**Flori. 301 Landscape Gardening 2+1 Sem. II**

Importance and scope of landscaping. Principles of landscaping. Garden styles and types. Water, Terrace, Vertical and Sunken gardens. Garden components- rockery, adornments, walk-paths, bridges and other constructed features etc. Trees, shrubs climbers, pot plants and annuals - selection, propagation, planting schemes, canopy management. Other garden plants - palms, ferns, cacti and succulents. Bio-aesthetic planning - definition, importance and planning. Landscaping of urban and rural areas. Peri-urban landscaping. Preparation of landscape plans for home, schools and public places like townships, river banks, hospitals, play grounds, industries, institutions. Bonsai – principles, types, techniques and management. Lawn - establishment and maintenance. CAD application.

**Practical :** Identification of trees, shrubs, climbers, pot plants and annuals. Care, propagation and maintenance of plants. Potting and repotting of plants. Identification of tools and implements used in landscape gardening. Training and pruning of plants for special effects. Lawn establishment and maintenance. Layout of formal and informal gardens. Types of gardens – sunken, terrace and rock gardens. Designing of conservatory and lathe house. Use of computer software. Visit to important gardens/parks/ institutes.

**Flori. 302 Breeding and Seed Production of Flower and Ornamental Crops 2+1 Sem. I**

History of improvement of ornamental plants, Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, polyploidy, mutation and biotechnological technique for improvement of ornamental and flower crops *viz*., Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, dahlia Heliconia, Lilium, Petunia, *Hibiscus*, Bouganvillea, Zinnia, Dianthus, Snapdragon, Pansy, crossandra, marigold, geranium, antirrhinium, china aster, orchids, anthurium, carnation, hibiscus etc. Breeding for disease resistance. Development of promising cultivars of important ornamentals and flower crops. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

**Practical:** Study of floral biology and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods.

## Postgraduate Courses

### M.Sc. Courses

**FLS-501 Systematics of Ornamental Plants 2+1 Sem. I**

**Unit I** History, origin, hotspots, classification and nomenclature systems.

**Unit II** International Code, Treaties, International and National Organisations, Biodiversity Act, Identification features, descriptors.

**Unit III** Red Book, Registration (NBPGR, PPVFRA, NBA).

**Unit IV** Description and families and important genera Rosaceae, Asteraceae, Caryophyllaceae, Orchidaceae, Aracaceae, Liliacae.

**Unit V** Acanthaceae, Palmaceae, Asparagaceae, Malvaceae, Musaceae, Oleaceae, Iridaceae.

**Unit VI** Molecular techniques in modern systematics.

**Practical** : Different nomenclature systems of plants, Floral biology and taxonomic description of rose, chrysanthemum, orchids, carnation, gerbera, anthurium, marigold, tuberose, Jasmine, China aster, lilium, gypsophila, Cryopreservation and tissue culture repository, Molecular techniques.

**FLS-502 Breeding of Ornamental Crops 2+1 Sem. II**

**Unit I** Origin, evolution, distribution, introduction, domestication and conservation of ornamental crops.

**Unit II** Introduction and initiatives in IPR and PBR of ornamental crops.

**Unit III** Breeding objectives, reproductive barriers (Male sterility, incompatibility) in major ornamental crops. Inheritance of important traits, Genetic mechanisms associated with flower colour, size, form, doubleness, fragrance, plant architecture, post-harvest life, abiotic and biotic stress tolerance/ resistance.

**Unit IV** Breeding methods suitable for sexually, asexually propagated flower crops, self and cross pollinated crops- pedigree selection, backcross, clonal selection, polyploidy and mutation breeding, heterosis and F1 hybrids.

**Unit V** Role of biotechnology in improvement of flower crops including somaclonal variation, in vitro mutagenesis, genetic engineering, molecular markers etc.

Crops- Rose, chrysanthemum, carnation, gerbera, gladiolus, orchids, anthurium, lilium, marigold, jasmine, tuberose, dahlia, gaillardia, crossandra, aster etc., Flowering annuals: petunia, zinnia, snapdragon, stock, pansy, calendula, balsam, dianthus etc. Important ornamental crops like aglaonema, diffenbachia, hibiscus, bougainvillea, tecoma, kalanchoe etc.

**Practical:** Floral biology of important ornamental crops, Cytology and cytogenetics. Selfing and crossing procedures for important ornamental crops. Evaluation of hybrid progenies. Induction of mutants through physical and chemical mutagens. In vitro selection, genetic engineering. Induction of polyploidy. DUS testing.

**FLS-503 Commercial Production of Cut Flowers 2+1 Sem. I**

**Unit I** National and International scenario, importance and scope of cut flower trade, constraints for cut flower production in India**.** Soil analysis, soil health card.

**Unit II** Growing environment, open cultivation, protected cultivation, soil/media requirements, land preparation, planting methods, influence of light, temperature, moisture, humidity and microclimate management on growth and flowering.

**Unit III** Commercial Flower production – Commercial varieties, water and nutrient management, fertigation, weed management, crop specific practices, ratooning, training and pruning, pinching, deshooting, bending, desuckering, disbudding. Use of growth regulators, physiological disorders and remedies, IPM and IDM.

**Unit IV** Flower forcing and year round/offseason flower production through physiological interventions, chemical regulation, environmental manipulation.

**Unit V** Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Precooling, pulsing, packing, storage and transportation.

**Unit VI** Marketing, export potential, institutional support, Agri Export Zones, 100% Export Oriented units, Crop Insurance

Crops: Rose, chrysanthemum, gladiolus, tuberose, carnation, gerbera, orchids, lilium, anthurium, China aster, alstroemeria, bird of paradise, heliconia, alpinia, ornamental ginger, dahlia, gypsophila, solidago, limonium, stock, cut greens and fillers.

**Practical** : Identification of varieties, Propagation, Microclimate management, Training and pruning techniques, Pinching, deshooting, disbudding, desuckering, Practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, Harvesting techniques, post-harvest handling, cold chain, Economics, Project preparation for regionally, important cut flowers, crop specific guidelines for project financing (NHB guidelines), Visit to commercial cut flower units, Case studies.

**FLS-504 Commercial Production of Loose Flowers 2+1 Sem. II**

**Unit I** Scope, scenario and importance of loose flowers, constraints and opportunities in loose flower production.

**Unit II** Growing environment- Nursery management, pro-tray nursery under shade nets, soil and climate requirement, Field preparation, systems of planting.

**Unit III** Soil analysis, soil health card, water and nutrient management, weed management, training and pruning, special horticultural practices such as pinching and disbudding, use of growth regulators, physiological disorders and remedies, INM, IPM and IDM.

**Unit IV** Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

**Unit V** Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packaging and storage.

**Unit VI** Important local markets, Export potential, transportation and marketing, APMC and online trading, institutional support, Crop Insurance.

Crops: Rose, jasmine, chrysanthemum, marigold, tuberose, China aster, crossandra, gaillardia, spider lily, hibiscus, Nerium, barleria, celosia, gomphrena, Madar (*Calotropis gigantea*), nyctanthes (Harsingar), Ervatamia (Chandni), ixora, lotus, water lily, Michelia (Champa), gardenia, Ixora and balsam.

**Practical:** Identification of species and varieties, Propagation and nursery management, Training and pruning techniques, Fertigation, Foliar nutrition, growth regulator application, Crop protection, Pinching, disbudding, staking, harvesting techniques, Post-harvest handling, storage and cold chain, Project preparation for regionally important commercial loose flowers. crop specific guidelines for project financing (NHB guidelines), Cost Economics, Exposure Visits to fields.

**FLS-505 Ornamental Gardening And Landscaping 2+1 Sem. I**

**Unit I** Styles and types of gardens: Historical background of gardening, Importance and scope of ornamental gardening, styles and types of gardens, formal and informal style gardens. English, Mughal, Japanese, Persian, Spanish, Italian, French, Hindu and Buddhist gardens.

**Unit II** Garden components (living and non-living): arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, colour wheels , clock garden, bamboo groves, bonsai; Non -living components like- path, garden gate, fencing, paving and garden features like fountains, garden seating, swings, lanterns, basins, bird baths, sculptures, waterfalls, bridge, steps, ramps, Lawn-genera and species, establishment and maintenance.

**Unit III** Specialized gardens such as vertical garden, roof garden, terrace garden, water garden, sunken garden, rock garden, shade garden, temple garden, sacred gardens (with emphasis on native plants), Zen garden.

**Unit IV** Principles and elements of landscaping: Basic drawing skills, use of drawing instruments, garden symbols, steps in preparation of garden design, programmes phase, design, phase, etc. Elements and principles of landscape design. Organization of spaces, visual aspects of plan arrangement- view, vista and axis. Principles of circulation, site analysis and landscape, water requirement, use of recycled water.

**Unit V** Urban landscaping, Landscaping for specific situations such as residential, farm houses, institutions, corporate sector, industries, hospitals, roadsides, traffic islands, Children parks, public parks, xeriscaping, airports, railway station and tracks, river banks and dam sites and IT/ SEZ parks. Bio-aesthetic planning, ecotourism, theme parks, indoor gardening, therapeutic gardening...

**Practical :** Graphic language and symbols in landscaping, study of drawing instruments viz., 'T' square, setsquare, drawing board, etc., 2. Identification of various types of ornamental plants for different gardens and occasions, Preparation of land, planning, layout and planting, deviations from landscape principles, Case study, Site analysis, interpretation of map of different sites, use of GIS for selection, Enlargement from blue print. Landscape design layout and drafting on paper as per the scale, Preparation of garden models for home gardens, farm houses, industrial gardens, institutional gardens, corporate, avenue planting, practices in planning and planting of special types of gardens. Burlapping, lawn making, planting of edges, hedges, topiary, herbaceous and shrubbery borders. Project preparation on landscaping for different situations, creation of formal and informal gardens. Visit to parks and botanical gardens.

**FLS-506 Indoor Plants and Interior scaping** **1+1** **Sem. II**

**Unit I** Importance and scope of indoor plants and Interior scaping, Indoor plants and Indoor air quality. Factors affecting growth, development and flowering of Indoor plants.

**Unit II** Classification of indoor plants based on light, temperature, humidity and pollution tolerance, Description and cultivation of various indoor plants. Principles of interior scaping, Role in pollution mitigation.

**Unit III** Containers and substrates, preparation of growing media, propagation, training, grooming, nutrition, management of disease, pests and weeds. Maintenance of plants including repotting, foliar nutrition, light exposure and plant rotation. Media standards, Nursery and Export standards for potted plants, Nursery standards.

**Unit IV** Special gardens including miniature gardens and plant stand. Presentations like dish, terrarium, bottle gardens, hanging baskets, window boxes and Bonsai.

**Unit V** Vertical gardens- History, planting material, structures, containers, substrate, water and nutrient management, supplemental lighting.

**Unit VI** Marketing channels, Business models including plant rentals.

**Practical:** Identification of important house plants, Media and containers, Propagation, Cultural operations, maintenance and economics of indoor plants, Models for Interior scaping, Familiarization with different indoor gardens, Making of terrariums, bottle garden, dish garden and their economics, Making of vertical gardens and economics, Exposure visits.

**FLS-507 Nursery Management for Ornamental Plants** **2+1** **Sem. I**

**Unit I** Scenario of nursery industry and sexual propagation: Importance and present scenario and status of nursery industry in India and in the world , life cycles in plants, Propagation methods, Factors influencing seed germination of flower crops, dormancy, seed quality, packing, storage, certification, testing. Hormonal regulation of germination and seedling growth.

**Unit II** Methods of asexual propagation, rooting of soft and hard wood cutting under mist. Role of Plant growth regulators. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principles and methods, budding and grafting – selection of elite mother plants. Stock, scion and inter stock, relationship – Incompatibility.

**Unit III** Micro-propagation – principles and concepts, commercial exploitation in flower crops. Techniques - in vitro clonal propagation, direct organogenesis, embryogenesis, micro grafting, meristem culture. Hardening, packing and transport of micropropagules.

**Unit IV** Growing structures like mist chambers, tunnels, lath house, net house, growing media types, soil less culture and containers. Automation in nursery management.

**Unit V** Nursery – types, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, PPV&FR act and Quarantine system in India. Important quarantine pests and diseases, sanitary and phyto-sanitary issues threats to nursery Industry.

**Unit VI** Standards: Nursery standards, Hi-tech nurseries, garden centers.

**Practical :** Anatomical studies in rooting of cutting and graft union, Identification and production of plug plants, seedlings and saplings, Preparation of growing media and use of PGRs, Practice of propagation

through specialized structures cuttings, layering, budding and grafting, Case studies Micropropagation of ornamental crops and hardening, Visit to tissue culture labs and nurseries, Economics.

**FLS-508 Turf Grass Management** **1+1** **Sem. I**

**Unit I** History, present status and prospects of turf industry; basic requirements, site selection and evaluation, concepts of quality of soil pertaining to turf grass establishment, criteria for evaluation of turf quality.

**Unit II** Types, species, varieties, important breeders, grasses for different locations and conditions and their compatible groupings as per climatic conditions; Turfing for roof gardens.

**Unit III** Preparatory operations; Turf establishment methods such as seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, instant turfing (portable), hydro-seeding, synthetic turfing. Turf management – Irrigation, drainage, nutrition, special practices like aerating, rolling, coring, dethatching, verticutting, soil topdressing, use of plant growth regulators and micronutrients, Turf mowing – mowing equipment, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs, standards for turf, use of recycled water etc.,

**Unit IV** Making of different sports arenas: Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, residential and public parks, turfing of Govt. & Corporate office gardens, event specific preparation, turf colourants.

**Unit V** Exposure to different tools, gadgets, machinery used in turf industry.

**Practical :** Identification of turf grasses and turf machinery, Soil preparation, turf establishment methods, provision of drainage, Layout of macro and micro irrigation systems, Water and nutrient management, Special practices – mowing, raking, rolling, soil top dressing, weed management, Biotic and abiotic stress management, Project preparation for turf establishment, Visit to parks, model cricket grounds and golf courses, airports, corporates, Govt. organizations, Rejuvenation of lawns, Turf economics.

**FLS-509 Value Addition in Floriculture** **2+1** **Sem. II**

**Unit I** Scope and prospects of value addition, National and global scenario, production and exports. Types of value added products, techniques of value addition including tinting.

**Unit II** Value addition in loose flowers and product development- Gulkhand, floral tea, rose oil, rose water, Pankhuri, floral dyes, rose sherbet, floral ice creams, sweets, etc.

**Unit III** Selection of containers and accessories for floral products and decorations. Flower arrangement, styles, ikebana schools (ikenobo, ohara, sogetsuetc), Ikebana- moribana, nagiere, contemporary style.

**Unit IV** Dry flowers– Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; tips for collecting dry flower making, selection of stages for picking of flowers for drying, Techniques in dry flower making – Drying, glycerising, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; petal embedded handmade papers, Packaging and storage. Post drying management including moisture, pests and molds.

**Unit V** Essential oils; Selection of species and varieties (including nonconventional species), extraction methods, Packing and storage, Aromatherapy.

**Unit VI** Types of pigments, carotenoids, anthocyanins, chlorophyll, betalains; Significance of natural pigments as nutraceuticals, Extraction methods and applications in food, pharmaceutical and poultry industries.

**Unit VII** Synthetic and Natural dyes, dying techniques, colour retention,

**Practical :** Practices in preparation of different type of flower arrangements including bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers, Techniques in flower arrangement and floral decoration, Identification of plants for dry flower making, Practices in dry flower making; Preparation of dry flower baskets, bouquets, potpourri, wall hangings, button holes, greeting cards, wreaths, etc. Essential oil extraction units, Extraction of pigments, Visit to dry flower units, Economics of value added products.

**FLS-510 Protected Cultivation of Flower Crops** **2+1** **Sem. II**

**Unit I** Prospects and types of protected structures: Prospects of protected floriculture in India; Types of protected structures – Glasshouse/ polyhouse, shade net houses, mist chambers, lath houses, orchidarium, fernery, rain shelters etc.,

**Unit II** Principles of designing and erection of protected structures; Low cost/Medium cost/High cost structures; Location specific designs; Structural components; Suitable flower and foliage plants for protected cultivation.

**Unit III** Microclimate management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation, water harvesting

**Unit IV** Intercultural operations and crop regulation: Containers and substrates, media, soil decontamination, layout of drip and fertigation system, water and nutrient management, IPM and IDM, Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

**Unit V** Automation in greenhouses, sensors, solar greenhouses and retractable greenhouses, GAP/Flower labels, Export standards, EXIM policy, APEDA regulations for export, Non-tariff barriers. Crops: Rose, Chrysanthemum, Carnation, Gerbera, Orchids, Anthuriums, Lilium, Limonium, Lisianthus, heliconia, Cala lily, Alstromeria, etc.,

**Practical :** Study of various protected structures, Design, layout and erection of different types of structures, Practices in preparatory operations, growing media, soil decontamination techniques, Microclimate management, Practices in drip and fertigation techniques, special horticultural practices, Determination of harvest indices and harvesting methods, Postharvest handling, packing methods, Economics of cultivation, Project preparation, Project Financing guidelines, Visit to commercial greenhouses.

**FLS-511 CAD for Landscaping** **1+2** **Sem. I**

**Unit I** Principles of integrating the architecture and landscaping, Exposure to CAD (Computer Aided Designing) – Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing.

**Unit II** 2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying commands, Isometric drawings, Drafting objects. Using patterns in AUTOCAD drawing, Dimension concepts, Hyper linking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout.

**Unit III** 3D drawing methods, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software, ARCHICAD file system, Tools and Info box, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD.

**Unit IV** ARCHICAD organization tools, Dimensioning and detailing of designs, Landscape designing softwares and CD ROM for ornamental plant material (TRES, HIMFLORA, CAPSSA, etc), Attribute settings of components, Visualization tools for landscape preview, Data management, plotting and accessories for designing, Inserting picture using photoshop, Making sample drawing for outdoor and indoor gardens.

**Practical :** Practices in point picking methods. Using tool bars and icons. Using modifying tools and modifying comments, Isometric drawings. Using productivity tools. Drawing designs by AUTOCAD for home garden, institutional garden and special types of garden. Using tools and info-box for 3D drawing. Creation of garden components with ARCHICAD. Organization, dimensioning, detailing and visualization tools with ARCHICAD. Using Photoshop package for 3D picture insertion. Drawing designs with ARCHICAD for home garden, interior garden designing, IT parks, Corporates, Theme parks and Ecotourism spots. Exposure visits.

**FLS-512 Seed Production in Flower Crops** **1+1** **Sem. II**

**Unit I** Scope, scenario and importance of seed production in flower crops. Constraints in flower seed production. Marketing and economics of flower seeds.

**Unit II** Methods of seed production, agro-techniques for production of nucleus, breeder and certified seeds. Harvesting, seed processing, seed priming, seed chain, packaging and storage.

**Unit III** Population improvement: Mass selection, progeny selection. Use of incompatibility and male sterility, maintenance of variety and seed production in flower crops.

**Unit IV** F1 hybrid seed production advantages, steps involved in hybrid seed production, pollination behaviour and isolation, pollination management methods in production of F1/ hybrids in different flower crops.

**Unit V** Seed certification, Seed standards, seed act, plant breeders rights and farmers' rights, Bio safety, handling of transgenic seed crops, importing of seeds and OGL, trade barriers in seed business, sanitary and phytosanitaty issues, custom clearance and quarantine.

Crops: Marigold, petunia, antirrhinum, zinnia, pansy, lupin, calendula, phlox, vinca, dianthus, sunflower, annual chrysanthemum, poppy, corn flower, rice flower.

**Practical :** Seed production of open pollinated varieties. Seed production of cross pollinated varieties. Steps involved in hybrid seed production. Hybrid seed production in different flower crops like marigold, petunia, antirrhinum, zinnia, pansy, lupin, calendula, phlox, vinca, dianthus, sunflower, annual chrysanthemum etc. Visit to seed industry. Visit to quarantine facility.

**FLS-591 Seminar** **1+0**

**FLS-599 Master's Research** **0+30**

## Ph.D Courses

**FLS-601 Crop Regulation in Ornamental Crops** **2+1** **Sem. I**

**Unit I** Ecophysiological influences on growth and development of flower crops for flowering, Crop load and assimilate partitioning and distribution. Root and canopy regulation

**Unit II** Study of plant growth regulators including biostimulants and polyamines in floriculture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phyto hormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, Plant architecture management for flower crops and ornamental plants, molecular approaches in crop growth regulation.

**Unit III** Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, flower bud initiation, regulation of flowering, photo and thermo-periodism, off season production, bulb forcing techniques,

**Unit IV** Programmed production of important flower crops like chrysanthemum, tulips, lilium, daffodils, poinsettia, kalanchoe and gypsophila.

**Practical :** Plant architecture studies in important flower crops, Bioassay and isolation through chromatographic analysis for auxins, gibberellins, cytokinins, ABA, Growth regulation during propagation, dormancy, flowering, Photoperiod regulation in short day and long day crops, Off season production in important crops, Bulb forcing in bulbous ornamental crops, Exposure visits.

**FLS-602 Postharvest Biology of Floricultural Crops** **2+1** **Sem. II**

**Unit I** Pre harvest physiology: Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and other biochemical changes, respiration, transpiration in important flower crops.

**Unit II** Physiology and biochemistry of flowering, enzymatic changes, Ethylene sensitivity, ethylene evolution and management, factors leading to post-harvest loss, pre-cooling. Petal senescence at molecular level, functional gene analysis for postharvest flower quality in important flower crops etc.

**Unit III** Pigments and secondary metabolites: Biosynthetic pathways of chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins and betalains. Chemistry and importance of secondary metabolites. Biochemistry and utilization for commercial products in important flower crops.

**Unit IV** Storage of flowers: Treatments prior to shipment, viz., precooling, pulsing, impregnation, chemicals, Irradiation, biocontrol agents and natural plant products. Methods of storage: ventilated, refrigerated, Modified atmosphere, Controlled atmosphere storage, cool chain management, physical injuries and disorders in important flower crops.

**Unit V** Packing methods and transport, Smart technologies in packaging and storage, advanced tools like nanotechnology application for quality parameters and post harvest treatments for export in important flower crops, packaging standards, flower labels value chain in floriculture,

**Unit VI** Recent trends- extraction of bio-colours from flowers-conventional as well as in vitro methods and their value addition uses in food and textile industries. Molecular techniques for enhancing postharvest flower quality, transgenics in ornamental plants for enhanced postharvest life.

**Unit VII** Post harvest handling of dried ornamental crops including packing, storage and shipment. Storage pest and mould problems in dried ornamental produce, colour retention, physiological and biochemical changes, etc.

**Practical :** Improved packaging and storage of important flowers, Physiological loss in weight of flowers, estimation of transpiration, respiration rate, ethylene release and study of vase life, Extension in cut flower vase life using chemicals, Estimation of quality characteristics in stored flowers, Estimation of biochemical changes like enzymatic changes, lipids and electrolyte leakage, Extraction of flower pigments – Chlorophyll, xanthophylls, carotenoids and anthocyanins, Cold chain management - visit to cold storage, MA and CA storage units, Project preparation.

**FLS-603 Specialty Flowers, Fillers and Cut Greens 1+1 Sem. I**

**Unit I** Introduction, present status, scope, importance and avenues for specialty flowers and cut greens.

**Unit II** Cultivation practices of specialty flower crops like heliconia, red ginger, Bird of Paradise, Ornamental banana, ornamental curcuma, gingers, wax flower, kangaroo paw, limonium, rice flower, etc.

**Unit III** Cultivation practices of fillers like gypsophila, solidago, Mollucella, lupins,etc.

**Unit IV** Cultivation practices of cut greens like anthurium, ferns, asparagus, cycas, thuja, bottle brush, ornamental palms, Xanado, dracaena, eucalyptus, ruscus, dianella, alpinia, etc.

**Unit V** Pre and post-harvest factors influencing the vase life of the flowers and fillers, Post harvest management including pulsing, holding, packing, storing, forward and backward linkages, value chain management.

**Unit VI** Quality standards, Packaging standards, marketing and trade in important flower, filler and foliage crops.

**Practical :** Identification of specialty flowers, fillers and cut greens. Media and bed preparation for cultivation. Propagation of important crops. Integrated disease and pest management in important crops. Post harvest handling of specialty flowers, fillers and cut greens. Preparation of value added products from important specialty flowers, fillers and foliages. Exposure visits. Economics and Project preparation.

**FLS-604 Biotechnological Approaches in Floricultural Crops 2+1 Sem. II**

**Unit I** Present status of biotechnology, tools techniques and role in floriculture industry, physical factors and chemical factors influencing the growth and development of plant cell, tissue and organs, cyto-differentiation, organogenesis, somatic embryogenesis in important flower crops.

**Unit II** In vitro lines for biotic and abiotic stress – Meristem culture for disease elimination, production of haploids through anther and pollen culture – embryo and ovule culture, micrografting, wide hybridization and embryo rescue techniques, construction of somatic hybrids and cybrids, regeneration and characterization of hybrids and cybrids, in vitro pollination and fertilization, hardening media, techniques and establishment of tissue culture plants in the primary and secondary nursery in important flower crops.

**Unit III** Somoclonal variation and its applications – variability induction through in vitro mutation, development of cell suspension cultures, types and techniques, Synthetic Seed technology, in vitro production of secondary metabolites, role of bioreactors in production of secondary metabolites, quantification and quality analysis of secondary metabolites using HPLC/ MS/GCMS/ in vitro conservation and cryo-preservation techniques in important flower crops.

**Unit IV** Gene cloning, genetic engineering: vectors and methods of transformation – electroporation, particle bombardment, Functional gene analysis techniques like PTGS including VIGS in ornamental plants, Agrobacterium mediated, transgenic plants in flower crops, Biosafety of transgenics isolation of DNA, RNA, quantification, Polymerase Chain Reaction for amplification; AGE & PAGE techniques; identification of molecular markers in important flower crops.

**Unit V** Molecular markers as a tool for analysis of genetic relatedness and selection in ornamental crops. Molecular control of flower development, light sensing with respect to plant development, flower pigmentation, fragrance, senescence, ethylene synthesis pathway in important flower crops. Molecular biology- Gene isolation, characterization, manipulation and transfer in important flower crops. Construction of c- DNA library, DNA fingerprinting technique in economic flower crop varieties, RNAi, Genome editing basics, molecular approaches to control ethylene response, Fragrance, Plant Architecture, desirable flower traits, colour, shape, improving post-harvest life, improving resistance for environmental stress, approaches to improve flower development, pigment production, secondary metabolite production, post-harvest biotechnology of flowers, ornamental plants, achievements of bio-technology in flower crops.

**Practical :** Micropropagation, Pollen- Ovule and Embryo culture- Synthetic seed production, In vitro mutation induction, in vitro rooting – hardening at primary and secondary nurseries, DNA isolation from economic flower crop varieties – Quantification and amplification, DNA and Protein profiling – molecular markers, PCR Handling, Vectors for cloning and particle bombardment, DNA fingerprinting of flower crop varieties, Project preparation for establishment of low, medium and high cost tissue culture laboratories.

**FLS-605 Advances in Landscape Gardening** **1+2** **Sem. I**

**Unit I** Landscape design Commercial landscape gardening- History, Plant identification and ecology, Materials of garden design, Design making by different garden styles and types. Design principles in ancient and modern landscape. Principles of designing a commercial landscape project. Role of landscaping in environment improvement, ecology conservation(birds, butterflies, animals).Plant wealth for edges, hedges, herbaceous borders, trees, floral beds, water plants, cacti, ferns, palms, etc.

**Unit II** Assessing site and plants adaptability for different locations, Landscape engineering (Topographical survey and designing concept including GIS, GPS, Remote sensing), special techniques in garden landscaping (Burlapping, waterscaping, xeriscaping, hardscaping, lawn establishment, topiary styles specializing, bioaesthetic planning).

**Unit III** Preparation and drawing of site plan, learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing.

**Unit IV** Landscaping for different situations: Contemporary landscaping, Urban landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Inventory management, Landscape restoration, Assessing a successful design in site.

**Unit V** Maintenance of different types of gardens, waste water utilization, historical and archaeological garden sites, Permissions required for bigger projects, carbon sequestration, carbon credits etc.,

**Practical :** Plant identification, Materials of garden design, Design making by different garden styles and types, Assessing site and plants adaptability for different locations, Way of designing a commercial landscape project, Landscape engineering (Topographical survey and designing concept), Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials *(*AUTOCAD *& ARCHICAD),* GIS as a tool for spatial designing, Case study with the successful landscapist, Budget/Project cost estimating, Exposure visits.

**FLS-606 Vertical Gardening** **1+1** **Sem. I**

**Unit I** Present status of vertical gardening, benefits of vertical gardening, History of vertical gardens, role of indoor plants in mitigating pollution.

**Unit II** Factors influencing the growth and development of the plants includes light, humidity, temperature, nutrition, irrigation, growth regulation.

**Unit III** Making of vertical gardens: Containers, media, frames, cost effective components, cables, wires, nets for the vertical formations, modular living walls.

**Unit IV** Influence of green facades in providing thermal comfort, atmospheric cleansing and related environmental benefits, Energy saving potential of green façades, Aesthetic appeal of green structures and other relevant studies on urban greening.

**Unit V** Plants suitable, Dust mitigation, Radiation absorption, Pollution mitigation, Acoustic attributes of urban greening.

**Unit VI** Lifecycle, maintenance, Plants with low light, medium, high intensity requirement, cost effectiveness and overall sustainability of living walls.

**Practical :** Identification of plants. Components of vertical gardens. Designing of vertical gardens for different locations. Maintenance of vertical gardens. Economics. Project preparation. Exposure visit.

**FLS-607 Advances in Breeding of Flower Crops** **2+1** **Sem. II**

**Unit I** Role of biotechnology in improvement of flower crops; in vitro-mutagenesis, embryo culture, somaclonal variation, transformation, in vitro cryopreservation, somatic hybridization, anther and ovule culture including somatic embryogenesis.

**Unit II** Biosynthetic pathways of pigment, fragrance and senescence, flower form; chemistry and importance of secondary metabolites, genomics, proteomics, meta-bolomics.

**Unit III** Molecular breeding and Marker assisted selection; molecular characterization; construction of c-DNA library; High throughput sequencing.

**Unit IV** Genome editing: CRISPER CAS, gene pyramiding, allele mining. Breeding for biotic and abiotic stresses using biotechnological means; designer flower crops.

**Unit V** Advancements in important flower crops like rose, chrysanthemum, carnation, orchids, anthuriums, lilium, gerbera etc.,

**Practical :** In vitro mutagenesis, embryo culture, soma clonal variation, Somatic hybridization, anther and ovule culture and somatic embryogenesis, Genetic transformation, Genetic fingerprinting, Genome editing techniques, PCR, genomics, blotting techniques, Cloning, marker assisted selection, Bioinformatics.

**FLS-608 Current Trends in Production Technology of Floricultural Crops** **2+1** **Sem. I**

**Unit I** Commercial flower production; Scope and importance; Global Scenario in cut flower production and trade, varietal wealth and diversity; Soil and Environment; cut flower, loose flowers, dry flowers and essential oil trade, flower seed production. Special characteristics and requirements. Essential oil industry, recent advances in extraction methods. UN.

**Unit II** Propagation and multiplication; Greenhouse management; Soil/media decontamination techniques; Micro-irrigation; nutrition and fertigation; slow release fertilizers and biofertilizers; influence of environmental parameters, light, temperature, moisture, humidity and CO2on growth and flowering.

**Unit III** Crop Regulation: Flower forcing and year-round flowering through physiological interventions; Chemical regulation; Environmental manipulation, important insect pests, diseases, nematodes and their management through IPM and IDM, quarantine measures for export and other export norms.

**Unit IV** Advances in roses, chrysanthemum, carnation, tuberose, gladiolus, lilium, gerbera, orchids, anthuriums, etc.,

**Unit V** Mechanization, automation, ICT and AI in floriculture.

**Unit VI** Harvest indices, Harvesting techniques; Post harvest handling for local, distant and export market, Cluster production, Contract farming, FPOs, Value chain management.

**Practical :** Greenhouse management; Soil decontamination techniques, Micro-irrigation; Nutrition and fertigation, Special practices- bending, netting, pinching, disbudding, defoliation and chemical pruning etc, Photoperiodic and chemical induction of flowering, Assessing harvest indices; Post-harvest handling, Case studies, Visit to commercial cut flower and essential oil units.

**FLS-609 Advances in Protected Cultivation of Flower Crops** **2+1** **Sem. II**

**Unit I** Prospects of protected floriculture in India, growing structures, basic considerations in establishment and operation of green houses, functioning and maintenance. Global trade, forward and backward linkages for import clusters, International and national auction houses.

**Unit II** Environmental control systems in greenhouse, regulation of light through LEDs containers, substrate culture, soil decontamination techniques, aeroponics, hydroponics and vertical farming.

**Unit III** Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, lilium, cut foliage and potted ornamental crops; plant architecture management in ornamental plants.

**Unit IV** Advances in protected cultivation of important flowering (rose, chrysanthemum, carnation, gerbera, orchids, anthurium, lilium, and foliage plants (agloenema, monstera, dracaena, syngonium, pothos, diffenbachia etc).

**Unit V** Precision floriculture, Principles and concepts, enabling technologies of precision floriculture, remote sensing, sensors, automation in greenhouses, solar greenhouses, retractable greenhouses. Computers and robotics, decision support systems, apps, cold chain management, use of AI for production and trade

**Unit VI** PBR / IPR issues; Forward and backward linkages, 100% EOU, packaging and export standards, Cool chain Management, non-tariff barriers, APEDA regulations for export, marketing channels, auction houses, major markets.

**Practical :** Growing structures, basic considerations in establishment and operation of greenhouses, Environmental control systems in greenhouse, Containers, substrate culture, soil decontamination techniques. Crop regulation. Special horticultural practices under protected cultivation. Precision equipments, computers and robotics in precision farming. Harvest indices – harvesting, Post harvest handling, marketing. Export and cold chain management.

**FLS-691 Seminar I** **1+0**

**FLS-692 Seminar II** **1+0**

**FLS-699 Ph.D Research** **0+75**

# FORESTRY AND NATURAL RESOURCES

## PROGRAMME

**M.Sc. (Silviculture and Forestry)**

**COURSE REQUIREMENTS**

**M.Sc. (Silviculture and Forestry)**

| | |
|---|---|
| Field of Specialization | Silviculture, Agroforestry |
| Core Courses | SAF-501, SAF-502, SAF-503, SAF-504, SAF-505 |
| Minor Field | Forest Biology and Tree Improvement, Agricultural Economics, Agricultural Meteorology, Agronomy, Botany, Floriculture and Landscaping, Fruit Science, Soil Science, Vegetable Science or any other as approved by Dean, Postgraduate Studies. |
| Supporting Courses | Stat.-502 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## DIPLOMA COURSES

**Forst. 51 Elementary Agroforestry** **1+1** **Sem. I**

Introduction and importance of forests. State of forest cover and tree cover. Forestry, farm forestry, social forestry and agroforestry. Overview of national and global agro-forestry systems. Methods of growing trees with crops - boundary/block planting, alley cropping, windbreak/ shelter belts and homestead gardens. Agroforestry benefits/ limitations, and ecological and economic interactions. Choice of trees and crops for combined culture. Fodder, fuel, timber and other multipurpose trees for agroforestry. Environmental services of agroforestry plantations. Methods of regeneration, cultural practices and tending operations for agroforestry trees. People participation and role of national/international agencies. Agroforestry policy.

**Practical** : Identification of various agroforestry and other important forest trees. D & D exercise. Field layout of boundary/block plantations. Measurements of tree and crop parameters. Propagation and nursery practices for forest trees. Seed collection and handling. Agroforestry farm visits.

## UNDERGRADUATE COURSES

**Forst. 102 Introduction to Forestry** **1+1** **Sem. II**

Forestry - Introduction, related definitions. Objective of silviculture. Forest classification. Indian Forest Policies. Artificial and natural regeneration – objectives, choice between natural and artificial regeneration. Coppicing, pollarding, root suckers. Tending operations – weeding, cleaning and thinning methods. Forest mensuration – objectives, instruments for diameter, height and age measurement. Non instrumental and instrumental height measurement methods - shadow and single pole method, geometric and trigonometric principles. Tree stem form, form factor, form quotient. Measurement of volume of felled and standing trees. Agroforestry – definitions, importance, systems prevalent in the country and criteria of tree selection. Shifting cultivation. Taungya. Alley cropping. Home gardens. Wind breaks and shelter belts. Cultivation practices of two important fast-growing tree species of the region.

**Practical** : Identification of tree-species. Diameter measurements of forked, buttressed, fluted and leaning trees. Height measurement of standing trees by shadow method, single pole method and hypsometer. Volume measurement of logs using various formulae. Nursery lay out, seed sowing, vegetative propagation techniques. Nursery raising practices of important tree species. Forest plantations and their management. Visits to nearby forest-based industries.

**Forst. 103 Forest Resource Management** **1+1** **Sem. II**

Forestry - Definition, scope and important terminology. Status of forests in India. Principles of forest management; scope, objectives and peculiarities of forest management with other land-use systems. History of forest development in India. Salient features of Forest Policies and Acts. National and International Forestry Organizations. Choice of species. Progressive yield. Growing stock (even and uneven aged forest), concept of normal forest, increment and rotation. Principle and concept of Sustainable Forest Management (SFM). Prerequisite, Criteria and indicators for SFM. Thinning and other intermediate treatments. Preparation of Management Plan Maps and Working Plan Maps. Forest based industries. Inter-regional and international trade in forest products. Financial criteria of forest project evaluation - NPV, IRR, B/C and Land Expectation Value (LEV). Natural and environmental resource accounting - methods and implications. Forest valuation of timber and non-timber forest products.

**Practical :** Identification of trees. Measurement of volume and biomass. Marketing channels of major and minor forest produce Methods of sale of forest produces in different forest timber depots. Estimation of demand and supply functions. Financial and economic appraisal of forestry projects. Discounting concepts and measures (Financial criteria - NPV, IRR, and B/C ratio). Environment Impact Assessment. Model project preparation of plantation establishment of any tree species. Methods of valuation of timber and non-timber forest products. Computer applications for using programming techniques in evaluating forest management. Visits to different forest-based industries.

**Forst. 301 Introductory Agroforestry** **1+1** **Sem. I**

Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry. Status of Indian Forests and role in Farming systems. Choice of species w.r.t. site/economic uses and constraints on tree growing. Agroforestry system, sub-system and practice: agri-silviculture, silvipastoral, horti-silviculture, horti-silvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree - crop species for agroforestry. Agroforestry projects – national and overseas. National Agroforestry Policy 2014. MPTs (*Melia* spp., *Azadirachta indica, Acacia catechu, Acacia nilotica*, *Dalbergia sissoo*, *Tectona grandis*, *Populus deltoides*, *Morus alba*, *Grewia optiva*, *Eucalyptus* spp., *Gmelina arborea*, *Leucaena leucocephala,* bamboo, etc.) – nursery and planting management practices and economics.

**Practical** : Identification and seeds and seedlings of multipurpose tree species. Nursery practices for *Populus deltoides, Morus alba, Acacia catechu, Dalbergia sissoo, Azadirachta indica, Melia composita, Leucaena leucocephala,* Bamboo etc. Layout of agroforestry plantation and study the compatibility of MPTs with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks. Visit to social forestry/agroforestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts. Rapid assessment of farmers'/industries' needs for timber, fodder, fuel wood, etc. Economics and marketing of products raised in agroforestry systems.

**Forst. 491 Agro-industrial Attachment** **0+4** **Sem. I**

The students opting for this module under 491 series courses as Agro-industrial attachment will be attached for hands on training at either of the following locations/industries:

Forest based Industry (Ply wood/ Furniture/Paper & Pulp, etc.)

High-tech Nursery (Tree Planting Stock Production) in public/private nurseries/farms

**Forst. 492 Experiential Learning in Nursery Production of Agro-forestry Trees** **0+20** **Sem. II**

The students opting for this module under Experiential Learning Modules shall raise the nursery of assigned agro-forestry tree(s) as per the recommended PAU Packages of Practices for Forest Trees.

## POSTGRADUATE COURSES

**M.Sc. Courses (Major: Silviculture and Forestry)**

**SAF-501 Silviculture** **2+1** **Sem. I**

Forest cosystems-Introduction to tropical/temperate silviculture. Role of silviculture in forest and wild land management, major forest formations-classification, distribution, composition and structure. Vegetation dynamics- species richness-diversity indices. Vegetation forms of India and their productivity. Foresteco system-structure and functioning, community development, competitive interaction sin forest communities, forest succession, concept sand models of succession-Connell-Slatyermodels, climaxtheories, tolerance. Ecophysiology of tree growth- effect of radiation and water relationship, mineral nutrients and temperature. Forest stand development - stand development, even-aged and uneven-aged stands, age and site quality. Tree architecture and itsrolein stand management. Stand density determination-stand density indices-stand density management- density management diagram, silvicultural treatments involved-thinning as a stand management tool, objectives of thinning, effects on growth and yield, thinning effect on economic yield of stands. Forest sit equality evaluation-direct and indirect methods. Treatment analysis-silvicultural regimes- factors influencing choice of regimes, use of system analysis to determine regimes, models for evaluating silvicultural alternatives, development of silvicultural regimes to suit management objectives, optimum Management strategies, silvicultural prescriptions for maximum production regime.

**Practical** : Visit to forest areas to study forest composition, classification, factors of locality, site quality, form and growth of forest trees- study plant succession- study stand density, changes on productivity-thinning effects.

**SAF-502 Forest Biometr** **1+1 Sem.I**

Measurement of tree parameters. Determination of tree age and dendrochronology for growth history and climate change studies. Estimation of volume, growth and yield of individual tree and forest stands. Preparation of volume tables. Application of yield and standtables. Forest inventory, sampling methods adopted in forestry, Use of GIS inforest inventory. Quantification of regeneration and stand establishment. Measurement of crown density and crown ratios. Simulation techniques. Growth and yield prediction models–their preparation and applications.

**Practical** : Calculations of volume of felled as well as standing trees. Volume table preparation. Application of different sampling methods. Preparation of yield and stand table. Quantification of regeneration and stand establishment. Measurement of crown density and crown ratios. Crown profiling of trees and stand. Dendro chronological studies.

**SAF-503 Silvicultural Practices** **1+1 Sem. II**

Silviculture under changing context of forestry- silviculture and ecosystem management, standdynamics, silvicultural practices for pure and mixed stand, even aged and uneven aged stand –silvicultural practices for changing climatic conditions. Silvicultural practices for natural and artificial regeneration – Ecology of regeneration, forest site management- enrichment of site – quality classes and site index models – stand density – spacing and tree growth – forest vegetation management – techniques for early stand growth- tending operations. Biomass allocation: belowground and aboveground. Changing trends in adoption of silvicultural systems. Stand development – stages- crown dynamics, Crown Competition factor, Maximum crown area, thinning-pruning–response of trees and impact on wood quality, salvage cutting–improvement felling and enrichment planting – management of weeds, Invasive weeds in forests, Silvicultural practices for short rotation forestry-coppice forestry, Continuous cover forestry. Site specific selection of tree species. Precision silviculture –silvicultural practices for important fast-growing trees and bamboos of India- Populus species, Neolamarkia cadamba, Eucalyptus sp., Casuarina sp., Tectona grandis, Meliadubia, Dalbergia sissoo, Gmelina arborea, Leucaena leucocephala, Ailanthus excelsa, Azadirachta indica, Swietenia macrophylla, Dendrocalamus sp.,Bambusasp.,-Mechanization of silvicultural practices.

**Practical** : Visit to different forest sites to study the influence of site factors on composition, Determination of site quality; Studies on stand structure and composition of different forest types; Practicing pruning and its impact on wood quality; Characterizing methods of thinning; Working out intensity of thinning; Study of stand densities in natural forest stand and plantation stand, Afforestation techniques, Wood management techniques for forest tree crops. Planning and designing a tree planting programme. Exercise on precision silviculture practices. Exercise on mechanized silvicultural practices.

**SAF-504 Agroforestry Systems** **2+1 Sem. I**

Agroforestry: objectives, importance, potentials and limitations for implementations .Land capability classification and land evaluation. Basis of classification of agro forestry systems and principles, indigenous *vs.* exotic, intra specific variations, crown architecture of tropical/temperate trees. Ideotype concept for selection of multipurpose trees. Nitrogen fixing trees. Overview and case studies of different agro forestry systems. Structural and functional attributes of agroforestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, silvopast oral systems, shelter-belts and wind breaks, energy plantations and home gardens. Role of trees in soil productivity and conservation– micro-site enrichment- litter and fine root dynamics, Nitrogen fixation and nutrient pumping. Soil productivity and management in agroforestry. Community forestry and social forestry, linear strip plantations. Trend sin agroforestry systems research and development, Diagnosis and Design–PRA-RRA tool sin agroforestry problem diagnosis. Climate Change mitigation and adaptation through agroforestry- climate negotiations-LULUCF-agroforestry options.

**Practical** : Survey and analysis of land use systems in the adjoining areas. Study of tree crown architecture. Design and plan of suitable models for improvement. PRA-RRA tools in agroforestry problem diagnosis.

**SAF-505 Interaction in Agroforestry Systems** **1+1 Sem. II**

Tree-crop inter phase-biological factors affecting for mand function in woody and non-woody plant

mixtures. Nature and types of interactions- positive and negative, aboveground and below ground interactions-competition, complementarily in resource sharing. Method for quantifying interactions, principles of resource capture and utilization of light and water, nutrition and space. Tree-soil-crop interactions- nitrogen fixing trees interactions in agroforestry. Allelopathy Use of radio isotopesintree-cropinteraction studies. Root distribution of trees and crops-competition and/or complementarity. Animal-tree-crop interaction. Management options to neutralize negative (competitive) interactions, tree husbandry practices for alleviating competition- tree density manipulation, pruning, mixture of trees and herbaceous crops.

**Practical** : Different methods for quantifying interactions. Studies on allelopathy. Effect, micro climate modifications, different plant mixtures, tree-soil-crop interactions. Estimation of Land Equivalent Ratio, Estimation of competition indices, Measurement and interpretation of light interception in agroforestry systems, Interpretation of yield responses to shelter, soil water and drainage measurement, transpiration measurement, quantifyingroot distribution.

**SAF-506 Modern Nursery Technologies 1+1 Sem. II**

Introduction and importance of nursery. Types of nurseries-temporary and permanent, bare root, containerized and clonal nursery. Bare root nursery- nursery soil and water management, bed preparation, pre-sowing seed treatments, seed sowing and intermediate operations *viz.,* pricking, watering, fertilization, weed in gandhoeing. Physiology and nursery m environment interaction affecting seedling growth. Root culturing techniques. Containerized nursery - type and size of containers including root trainers, selection of growing medium. Types of greenhouse and mistchamber for propagation. Vegetative propagation - importance, selection of superior genotypes, Advanced methods of propagation, containers, growing media, fertilizers, sanitation and management in vegetative propagation. Special requirement for clonal propagation. Propagation Structures and Management, propagation: mini clonal and micro cuttings technology. Vegetative propagation of bamboos and canes. Factors affecting rooting of cuttings. Lifting windows. Important forest nursery pests and diseases and their management. Seedling quality assessment, grading, packaging, storing and transportation.

**Practical** : Introduction and identification of modern equipments and tools used in nursery. Pre-sowing seed treatments. Preparation of nursery beds and growing media for containerized nursery. Sowing of seed and other intermediate operations. Preparation and planting of cuttings. Use of vegetative propagation methods such as budding, grafting and layering. Mini clonal and microcutting technology. Use of plant bio-regulators for rooting. Assessment of seedling quality. Maintenance of nursery records. Identification of nursery insects and diseases and their control measures. Visit to forest nurseries. Nursery practices of commercially important tree species.

**SAF-507 Plantation Forestry 2+1 Sem. I**

Role of plantation forestry in meeting the wood demand–status of plantation forestry in India and world. Purpose of plantation, factors determining scale and rate of plantation. Land suitability and choice of species. Preliminary site preparation for establishing plantation. Plantation planning, project formulation and appraisal. Planting programme, time of planting, spacing, pattern and planting methods. Nutritional dynamics and irrigation of plantation. Mechanization in plantation. Protection and aftercare of plantation. Pruning and thinning in plantations for quality wood production. Rotation in plantation. Failures of plantations. Impact of interaction and integration of plantation forestry. Protective afforestation, afforestation of inhospitable sites. Plantation forestry for climate change mitigation-carbon forestry. Ecological factors and long-term productivity. Sustainable yield from plantations. Case studies in plantations of Eucalyptus, Casuarina, Poplars, Acacias, Pine, Silver Oak, Gmelina, Teak, Sandal, Bamboo, etc. Production technology of energy plantations, industrial plantations. Emerging concepts in plantation forestry:mixed plantation, continuous cover forests.

**Practical** : Analysis of plantation problems in Asia and India. Preparation of plantation calendar–Preliminary arrangement for a plantation programme. Planting geometry and calculation of planting stock. Study of different cultural operations and site preparation for plantation. Studies on wood-based industries – problems and prospects. Management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacias and Bamboo plantations. Production technology for energy plantations. INM in plantations. Irrigation and plantations. Economics of pulpwood, timber and energy plantations. Study of mixed plantation model.

**SAF-508 Industrial Agroforestry** **1+1 Sem. II**

Role of forests in industrial sector, industrial raw material, demand and supply, indigenous and exotic industrial resources, extent of area, policy and legal issues towards industrial wood plantation. Major wood-based industries in India; timber, pulp wood, plywood, matches etc. Raw material requirements and their procurements. Industrial wood plantations – status in India and different states, preferred species – current plantation management and establishment, propagation and plantation technique, economics of industrial agroforestry, pest and disease management for major industrial wood species, harvesting, reduced impact logging, mechanization. Supply chain; definition, concept, supply chain network, logistic activities, Marketing system; marketing type and channel, price patterns of various industrial wood agroforestry plantations. Contract farming: concept and methods, contract tree farming system in India. Industrial experiences–price support system–constraints. Corporates ini ndustrial agroforestry: International and National corporate, success stories. Corporate social responsibilities. Tree insurance. Impacts of industrial agroforestry – ecological impacts; climatic, edaphic and biotic–carbon sequestration. Carbon storage potential of industrial agroforestry and carbon trading mechanism of industrial agroforestry, socio-economic impacts–clean development mechanism. Certification of industrial plantations.

**Practical** : Study of various wood-based industries. Study on raw material requirement and sourcing of plywood, pulp and paper, matchwood, timber processing. Biomass power generation industries. Value addition technology of various wood products. Industrial wood plantations – economics and impact assessment.

**SAF-509 Climate Change and Conservation Silviculture** **2+0 Sem. I**

Global climate change-factors involved, green house gases, potential threats, global carbon cycleand C-budget, carbon sequestration. Forests and climate change: Forest responses and vulner abilities to climate change mitigation. Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation, UNFCCC, IPCC, CoP: LULUCF, REDD++and CDM. Silviculture and sustainability-criteria and indicators for sustainable plantation forestry in India-CIFOR guidelines. Silvicultural and stand management strategies for carbon sink maximization and sour ceminimization. Adaptive silviculture for climate change. Disturbance- natural and anthropogenic, short- and long-term impacts and their implications. Fire loss estimation in forests. Deforestation and degradation trends at global, national and regional levels. Mega development projects, Road widening projects and conservation of native and threatened pecies, management and rehabilitation plans. Impacts of 'No Green Felling' on stand productivity and health. Restoration forestry-silvicultural treatments for habitat restoration, catchment area treatments, enrichment planting, Analog forestry for site productivity and carbon value. Expanding forest and tree coverarea-TOF sector in India. Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Forestry. Silviculture of old growth stands and sacred grooves-their ecological significance and biodiversity values. Carbon sequestration potential of Trees Outside forests (TOFs), home gardens and urban forests.

**SAF-510 Trees and Shrubs for Agroforestry** **1+1 Sem. II**

Introduction, importance of woody elements in agroforestry systems, the irrolein biomass production. Suitability of species for different purposes. Multipurpose trees in agro forestry from system Fodder trees/shrubs and their nutritive value, propagation techniques. Role of nitrogen fixing trees/ shrubs. Choice of species for various agro-climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of trees and shrubs for agroforestry. Fruit crop and small timber trees and their need and relevance in agroforestry, trees suitable for various assemblage and their planting plan in different agroclimatic zones and agroforestry system.Inter cropping in fruit orchards like Apple, Walnut, Jack fruit, Mango, Sapota, Pomegranate, Orange, Citrus, Guavaetc. Modification in tending and pruning operation sand canopy management. Fertility management, yield and quality improvement.

**Practical** : Field survey and acquaintance with specialized features of trees, shrubs and fruit species and varieties for Agroforestry. Planting plans including wind breaks. Training and pruning of foresttrees,shrubs and fruit trees for enhancing production in agroforestry system.

**SAF-511 Economics of Agroforestry Systems** **2+1** **Sem. I**

Basic principles of economics applied to agroforestry. Financial measures. Quantification and valuation of inputs and outputs-direct and indirect methods. Optimization techniques- Planning, budgeting and functional analysis. Role of time, risk and uncertainty in decision making. Agroforestry budgeting. Risk analysis, re-assessment. Financial and socio-economic analysis of agroforestry projects. Principles of financial management and harvesting, post harvest handling, value addition, marketing of agroforestry products including benefit sharing. Valuation of ecosystem services in agroforestry and payment for ecosystem systems. Bankable agroforestry projects, incentives, tree insurance etc. Certification process in agroforestry-based carbon projects, carbon finance etc.

**Practical** : Exercises on agroforestry production relationships. Preparation of agroforestry-based enterprise, partial and complete budgets. Application of various methods in formulation and appraisal of agro-forestry projects. Case studies on harvesting, post harvest management and marketing of agro-forestry products. Valuation of ecosystem services in agroforestry and payment for ecosystem services.

**SAF-512 Tree Seed Technology** **2+1** **Sem. II**

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems, limiting factors in tree propagation and afforestation. Reproductive biology of seed plants - development and maturation of seed-bearing organs and seeds-morphology of fruit and seed-seed dispersal- ecological fruit and seed types-seasonality and periodicity of flowering and fruiting-reproductive age-influence of external factors on seed production. Seed structure and chemical composition–development and maturation–germination – breakdown of storage products – endogenous hormonal regulation – effect of stimulators and inhibitors–dormancy–its causes and breakage specific problems of seeds of woody plants. Determining maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing. Storage methods – loss of viability during storage. Dormancy and pre-treatment. Germination and seedling establishment and seed testing techniques. Quality seed production technologies-seed certification. Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Storage of orthodox, recalcitrant and intermediate seeds, Fumigation and seed treatment.

**Practical** : Identification of forest seeds. Seed sampling, different storage methods, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit. Tests of viability viz. cutting, hydrogen peroxide, excised embryo, tetrazolium, seed health testing primarily to the presence or absence of disease-causing organisms such as fungi, bacteria, virus and animal pests, recording, calculation and use of results of seed treatment.

**SAF-513 Nutrient and Weed Management in Production Forestry** **1+1** **Sem. I**

History of nutrient management in forest nurseries and plantations. Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/interactions. Concept of nutrient availability. Climatic and soil conditions causing micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements. Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency. Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers. Mycorrhizal associations and their significance. Economic implications of nutrient management. Importance of renewable wastes and their recycling. Principles of weed control. Methods of weed control-cultural, biological, mechanical and chemical. Herbicide/ weedicide classification, properties and their application.

**Practical** : Methods of soil and plant analysis. Preparation of nutrient solutions. Practical application of fertilizers. Study of fertilizer response and diagnosis of deficiency symptoms. Fertilizer testing and pot experiments. Nursery inoculation techniques of bio-fertilizers. Methods of application of formulated products-seed treatment, root dip, suckers treatment, soil application, foliar application and combination of different methods. Important weeds in forest nurseries and plantations. Control of weeds.

**SAF-514 Crops and Live Stock Management in Agroforestry 2+0 Sem. II**

Choice of inter-crops for different trees pecies, sowing and planting techniques. Planting patterns, crop geometry, nutrient requirements, and weed management. Management of fodder tree species, thinning, lopping, pruning. Ecological and socio-economic interactions. Role of tree architecture and its management on system's productivity. Production potentials of fodder-based agroforestry systems in different agro-climatic conditions and crop combinations. Importance of cattle, sheep and goatvis-à-visagro-forestry systems. Feed and fodder resources in agro-forestry systems and livestock management. Nutrient analysis of forages derived from fodder trees/shrubs. Nutrient requirement for various livestock and their ration computation with agroforestry forages and tree leaves. Forage and tree leaves preservation. Calendars for forage crop production in agro-forestry systems including lopping schedules. Optimization of animal production. Animal products technology and marketing. Integrated Agroforestry Farming System.

**SAF-591 Seminar 1 + 0**

**SAF-599 Master's Research 0+30**

M.Sc. Courses (Minor: Forest Biology and Tree Improvement) to be offered by the department to the students of M.Sc. Forestry (Silviculture and Agroforestry)

**FBT-501 Applied Forest Tree Improvement 2+1 Sem. I**

General concept of forest tree breeding, tree improvement and forest genetics. Reproduction in forest trees, dimorphism, pollination mechanism. Pollen dispersal, pollinators. Attract ants for pollinators. Variation in trees, importance and its causes. Natural variations as a basis for tree improvement. Geographic variations–Ecotypes, clines, races and land races. Selective breeding methods-mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Seed orchards–type, functions and importance, Genetic testing-mating designs and field designs. Progeny and clone testing estimating genetic parameters and genetic gain, clonal and breed ingvalues. Average performance of half-sibs and full-sibs. GxE interaction in trees. Heterosis breeding: in breeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples-teak, shisham, eucalypts, acacias, poplaretc. Polyploidy, aneuploidy and haploidy in soft and hardwood species. Induction of polyploidy. Elements of biotechnology in tree improvement.

**Practical** : Floral biology, modes of reproduction and modes of pollination in forest trees. Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones. Identification of ecotypes, races and land-races in natural forest. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids. Induction of polyploidy through colchicines treatment. *Invitro* propagation, Molecular markers.

**FBT-502 Forest Ecology and Biodiversity Management 2+1 Sem. I**

Hierarchy issues in ecology and ecosystem. Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity, ecology of forest landscapes spatial heterogeneity and ecological succession Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Climate change, Global warming and forests. Green house effect and its consequences. Ozone depletion. Conservation laws and acts. Forest genetics resources of India: timber and nontimber species. Survey exploration and sampling strategies Phytogeography and vegetation types of India. Documentation and evaluation of forest genetical resources(FGR), *insitu* and *exsitu* conservation of gene resources. Phyto diversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

**Practical** : Study of forest community structure and its successional status, Estimation of productivity of forest ecosystem. Study tours to different regions of the state to study forest vegetation, Collection and preservation of specimen, Methods of vegetation analysis. Measurement of biomass and productivity. Quantification of litter production and decomposition,Visit to national parks, wild life sanctuaries. Botanical gardens and arboreta.

**FBT-503 Breeding Methods in Forest Trees** **2+1 Sem. II**

Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy-Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes. Long-term and short-term breeding populations. Selective breeding methods-mass, family, within family, family plus within family. Grading system of plus trees in natural stands and plantations selection index, regression systems, mother tree selection and subjective evaluation. Selection for different traits. Genetic testing programmes–mating designs,complete designs–nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs – open pollinated mating and polycrossmating. Improvement through progeny testing. Experimental designs in genetic testing. Breeding methods for wood quality, diseases and pest resistance, drought and salt resistance. Testing procedures for genetic advancement. Marker assisted selection. Tree improvement case histories.

**Practical** : Half-sib, full-sib family in trees. Grading system of plus trees in natural stands. Mating designs, complete pedigree designs–nested designs, factorial, single pair mating, full diallel, halfdiallel and partial diallel, incomplete pedigree designs–open pollinated mating and polycrossmating. Selection for biotic and abiotic stresses.

**FBT-504 Reproductive Biology of Forest Trees** **2+1 Sem. II**

Importance and application of reproductive biology in tree breeding. Crop characteristics-growth and development (both vegetative and reproductive). Floral diversity and pollination. Flower types pollination syndromes and their evolution. Plant –pollinator systems. Diversity of pollination syndromes in selected plant families. Modes of reproduction-sexual, asexual and vegetative and their breeding systems and sex expression, monoecy, dioecyandits evolution. Environmental effects on sex expression. Floral biology. Modes of pollination self and out-crossing. Floral attract ants and rewards biology of floral and extra floral nectarines examples of plant insect interactions involving pollination. Floral characteristics of the main pollination syndromes. Environmental effects on sex expression. Floral biology initiation and development. Modes of pollination self and out-crossing. Fertilization in hardwood and softwood species. Seed dispersal and gene flow.

**Practical** : Sex expression in forest trees. Out crossing mechanisms in forest trees. Measurement of pollen flow in wind-pollinated and insect-pollinated species. Pollen viability and fertility. Seed dispersal mechanism.

**FBT-505 Tree Seed Orchards** **2+1 Sem. II**

Importance of genetically improved seed in plantation forestry. Status of seed production among major plantation species. Short term supply of superior seed. Selection and delineation of seed stands, seed production areas, seed zones, seed ecological zones. Seed orchard: need, evolving seed orchards, containerized seed, hybrid and research seed orchards; first, second and advanced generation seed orchards. Seed orchard genetics: random mating, gamete exchange and parental balance. Estimation of genetic parameters from seed orchard data. Ortetageandits effect on seed production. Importance of progeny testing. Establishment of seed orchards, selection and preparation of orchard site, isolation, orchard size, and designs. Seed orchard management: rouging, silvicultural practices to increase seed yield. Pest and disease management. Seed collection and record keeping, seed orchard registration and documentation. Importance of seed orchard singene conservation.

**Practical** : Visits and study of seed orchard designs. Estimation of overlap in flowering among genotypes. Study of inter and intra-clonal variation in floral, seed characters. Effect of girdling on flowering. Plant growth regulator application for flower induction. Pollen viability/fertility. Assessment of pollen dispersal. Supplemental mass-pollination. Effects of foliar application of fertilizers on seed set. Estimation of genetic parameters for a few traits. Estimation of parental balance.

**FBT-506 Quantitative Genetics in Forest Tree Breeding** **2+1 Sem. II**

Causes of heterosis and its utility in various plants. Significance and estimation of genetic variance components. Heritability, its estimation by various methods and significance. Natural selection, fundamental theorem of natural selection (Fisher 1930). Selection responses. Correlation and its utility.

Partitioning of correlation into direct and indirect effects. Mating design, combining ability, general and specific combining ability and methods of its estimation. Genotypicx environment interaction, its significance. Various procedures for the estimation of genotypicx environment interaction.

**Practical** : Exercise on polygenic inheritance. Proof that quantitative characters are inherited in Mendelian fashion, estimation of genotypic and phenotypic variance in an experiment, estimation of additive and dominance components of variance through various procedures, mating designs and estimation of components of genetic variance, proof of population genetics law, exercise on calculation of gene and genotypic frequency, estimation of heterosis, estimation of heritability(broad sense and narrow sense) by various methods, genotypic and phenotypic correlation coefficients, partitioning of correlation into direct and indirect effects, estimation of general combining ability and specific combining ability, estimation of genotypicx environment interaction.

**FBT-507 Forest Genetic Diversity and Conservation 3+0 Sem. I**

Phyto diversity-concept, levels ecosystem. Genetic diversity and differentiation-definition, characteristics and importance for tree breeding. Genetic erosion. Techniques to assess genetic diversity. Analysis of karyotypic variation. Molecular approaches for assessing genetic diversity. Inventory and monitoring biodiversity: sampling strategies for genetic diversity assessments sufficiency of sampling procedures, neutral allele model and optimal allocation of sampling efforts. Methods of sampling of genetic diversity. Factors influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity Conservation biology& invasive species. Laws and policies. Methods for maintenance of conservation: gene banks, arboreta, botanical gardens, breeding populations as repositories of gene conservation. Rare, threatened biodiversity, endangered and endemise plants. Techniques for survey and assessment of endangered plants. Rarity patterns and endemism. Concept of island biogeography. Managing corridor sand natural habit atfragments. Monitoring and recovery plans for endangered plants. Plant community reserves. Managing wild flora tourism impacts and eco tourism and urban forestry of rare/exotic plants. Implications of rarity.

**FBT-508 Biotechnology in Forestry 2+1 Sem. II**

Introduction. Cloning, need for cloning, problems with cloning. Traditional cloning techniques versus micro-propagation, prospects of micro-propagation in forestry. Techniques procedures and problems in micro propagation, case studies. Protocols for micro-propagation. Preconditioning of explants, surface sterilization, nutritional media, other environmental factors controlling micro-propagation, choice of explants for micro-propagation. Micro propagation of juvenile material. Micro propagation of mature trees. *In vitro* propagation of plants with low sexual reproduction rates, miscellaneous application. Initiation and maintenance of callus. Organogenesis and somatic embryogenesis–factors influencing somatic embryogenesis-applications in forestry, Somatic seeds, encapsulation techniques. Soma clonal variation, genetic and epigenetic variation, exploitation in forestry. Cell suspension cultures. Anther and pollen cultures. Triploids through endosperm culture, embryo culture. Monoploid production by chromosome elimination. Applications of *In vitro* fertilization, isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization. Cryopreservation, storage of plant genetic resources. Production of secondary metabolites by cell cultures. Meristem culture, virus free plants. Genetic engineering-application in forestry Isozymes, restriction fragment length polymorphisms (RFLPs), randomly amplified polymorphic DNAs (RAPDs)and microsatellites. Genetic finger printing, Marker assisted selection. Different PCR techniques: their characteristics, with advantages and disadvantages. Quantification of genetic diversity, genotype verification and delineation. Introduction of genes. Promoters and marker genes. Disease resistance, herbicide tolerance and tolerance to salt and other stresses.

**Practical** : Introduction to tissue culture lab. Aseptic techniques. Preparation of culture media, formulation of different culture media. Induction and maintenance of callus, regeneration of plants from callus, regeneration of plants from embryoids. Cell suspension culture, Micropropagation techniques. Anther and pollen culture. Quantification of tissue culture, Isolation and culture of protoplasts. Marker assisted RFLP in test trees. Study of PCR techniques used in tree improvement. Application of GENALEX 'bolt on' for excel, arlequin, Pop Gene and FSTAT for Wright's F-statistics and analysis of molecular variance (AMOVA).

**FBT-509 Clonal Forestry** **2+0 Sem. I**

Introduction to Clonal Forestry. History of clonal forestry. Clonal propagation. Clonal planting. Strategies for clonal forestry for higher productive potential. Juvenility and maturation, rejuvenation and maintenance, regulation of phase changes, markers of phase changes. Breeding strategies using vegetative propagation- selection and breeding for extreme genotypes. Physiological research for higher productivity of clonal forest. Field design, testing and evaluation of clones. Genetic gains from breeding with clonaloption. Clonal conservation approaches- management of populations for genetic diversity and gain. Biotechnological approaches for clonal forestry, Plant tissue culture, micropropagation, Rejuvenation of tissues from mature trees, Testing of Clonal fidelity using molecular markers.

**FBT-510 Forest Ecophysiology** **2+1 Sem. II**

Forest environment interactions, Forest ecosystems, Geographic and climatic factors. Environmental factors influencing forest growth and productivity. Sun and shade plants. Influence of temperature, water stress and nutrient availability and disturbance in the forest on tree growth and forest productivity. Dynamics of forest ecosystems, energy, productivity and biomass. Decomposition and nutrient cycling. Stand structure and micro-climate, energy relationships canopy energy balance. Partitioning absorbed energy. Radiation penetration into and absorption by canopies. Air temperature and humidity in forests. Turbulent transfer process above forests. Transpiration and evapotranspiration from forest canopies. Estimation of ET.

Stress - avoidance and tolerance mechanisms. Temperature stress – low temperature stress –physiology of resistance to frost. Heat stress,heat injury, heat avoidance and tolerance mechanism. Radiation stress, mechanism of shade tolerance, water logging, physiology of resistance to water logging. Drought stress, salt and ion stress.

**Practical** : Morphological, anatomical and physiological variations between sun and shade plants, Estimation of leaf area, LAI, Estimation of biomass production of trees of different species, Estimation of microclimatic elements as influenced by stand structure, Estimation of evapotranspiration, Measurement of radiation in different types of Forest and agroforestry systems.

**FBT-511 Physiology of Woody Plants** **2+1 Sem. I**

Introduction, Tree physiology. Growth, phases of growth, growth curve, factors affecting growth. –Wood formation. Plant cellasa structural and functional unit. Organization of cell sand tissues, morphogenesis. Structure ofleaves, stemwood, barkand roots in trees. Function sand processing plant growth and development. Photosynthesis, structure of photosynthetic tissues and organs, enzyme, energetics and factors influencing photosynthesis. Photorespiration, its mechanisms and significance, factors affecting photorespiration. Respiration, mechanisms, enzymes, energetics and factors influencing respiration. Respiratory quotient. Water relations of trees, absorption, ascent of sap. Translocation of solutes, phloem loading and phloem transport. Transpiration, mechanisms and factors influencing, regulating transpiration, antitranspirants. Mineral nutrition. Mineral salt absorption and translocation, deficiency and toxicity of mineral nutrients. Diagnosis of mineral deficiency. The enzymes, nomenclature and classification, structure and compositioned. Mode of action. Phytohormones, auxins, GA, cytokinins, ABA, ethylene. Biosynthesis and biochemical activity of plant hormones. Synthetic plant growth regulators. Growth retardants. Nitrogen fixing trees, Nitrogen metabolism. $N_2$ fixation, physical and biological. Nitrogen assimilation, Amino acid and protein synthesis. Fat metabolism. Carbohydrate metabolism.

Practical : Preparation of growth curves of different tree seedlings. Study of structure of leaves, Measurement of photosynthesis. Observing structure of plant cells and leaves in C3 and C4 species, studying stomata in different tree species and working out stomatal frequency. Measurement of stomatal size in different tree species. Estimation of transpiration rates in different trees, Isolation and estimation of chlorophyll. Observing xylem vessel size variation in tree species. Estimation of plant water status by different methods. Nutrient deficiency symptoms in tree seedlings.

**FBT-512 Breeding for Insect Pest and Disease Resistance in Trees** **2+1 Sem. II**

Need for disease resistance in forest trees, Process of infection. Variability in plant pathogens. Types of resistance. Inheritance of resistance. Disease resistance mechanisms in trees, Clonal resistance.

Disease resistance breeding techniques. Techniques of isolating resistant genes; developing disease resistant transgenic plants. History and importance of insect pest resistance, types and mechanism of resistance. Insect-tree relationships. Basis of resistance: Induced resistance and acquired resistance. Defence mechanisms against insects. Factors affecting tree pest resistance. Breeding for insect resistance.

Practical : Disease progression in relation to resistance, disease resistance in clonal plantations and seed orchards, hypersensitivity and its mechanisms, disease resistance screening. Screening for insect pest resistance; chemical and morphological characterization of susceptible / resistance tree species. Defence strategies of woody plants.

**FBT-513 Tree Seed Technology** **2+1** **Sem. I**

Trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems, limiting factors in tree propagation and afforestation. Ecological fruit and seed types - seasonality and periodicity of flowering and fruiting. Seed structure and chemical composition development and maturation germination break down of storage products endogenous hormonal regulation effect of stimulators and inhibitors. Dormancy its causes and breakage specific problems of seeds of woody plants. Determining optimal harvest maturity indices. Methods of seed collection and processing. Storage methods–loss of viability during storage. Dormancy and pre-treatment and seed testing techniques. Quality seed production technologies – Seed stand/ seed production area, pollen management in seed orchards. Seed transfer guidelines. Seed certification and legislation. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigour. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment. Seed fortification. Seed pelleting.

**Practical** : Identification of forest seed. Seed sampling, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit. Different storage methods. Pre-treatment of seed. Seed fortification, seed pelleting.

# COURSE CURRICULUM FOR B.Sc. (Hons.) Horticulture
# 4 -YEAR PROGRAMME

## DEFICIENCY COURSES

| | | | Th + Pr |
|---|---|---|---|
| | For PCM base | | |
| 1. | Bio. 102 | Introductory Biology | 2(1+1) |
| | For PCB base | | |
| 1. | Math. 103 | Elementary Mathematics | 2(2+0) |

## REQUIRED COURSES

## HORTICULTURE

| | | | |
|---|---|---|---|
| 1 | Hort 101 | Elements of Fruit Science | 3 (2+1) |
| 2 | Flori 101 | Ornamental Horticulture | 2 (1+1) |
| 3 | Hort 102 | Tropical Fruits | 3 (2+1) |
| 4 | Hort 104 | Sub-Tropical Fruits and Plantation Crops | 3 (2+1) |
| 5 | Veg 101 | Tropical and Sub-Tropical Vegetable Crops | 3 (2+1) |
| 6 | Flori 102 | Principles of Landscape Architecture | 2 (1+1) |
| 7 | Hort 205 | Plant Propagation and Nursery Management | 3 (2+1) |
| 8 | Veg 201 | Temperate Vegetable Crops | 3 (2+1) |
| 9 | Forst 301 | Introductory Agroforestry | 2 (1+1) |
| 10 | Flori 201 | Commercial Floriculture | 3 (2+1) |
| 11 | Veg 204 | Breeding of Vegetable, Tuber and Spice Crops | 3 (2+1) |
| 12 | Hort 204 | Temperate Fruits | 3 (2+1) |
| 13 | Hort 206 | Breeding of Fruit Crops | 2 (1+1) |
| 14 | Hort 303 | Postharvest Management of Horticultural Crops | 3 (2+1) |
| 15 | Hort 305 | Fundamentals of Growth and Development of Horticultural Crops | 3 (2+1) |
| 16 | Veg 305 | Production Technology of Potato and Tuber Crops | 2 (1+1) |
| 17 | Hort 304 | Dryland Horticulture | 3 (2+1) |
| 18 | Hort 306 | Orchard and Estate Management | 2 (1+1) |
| 19 | Veg 304 | Seed Production of Vegetable, Tuber and Spice Crops | 3 (2+1) |
| 20 | Flori 302 | Breeding and Seed Production of Flower and Ornamental crops | 3 (2+1) |
| 21 | RAWE 401 | General Orientation and On-Campus Training | 1 (0+1) |
| 22 | RAWE 402 | Village Attachment | 8 (0+8) |
| 23 | RAWE 403 | KVK and Research Station Attachment | 5 (0+5) |
| 24 | RAWE 404 | Plant Clinic | 2 (0+2) |
| 25 | AIA 491 | Agro-Industrial Attachment | 4 (0+4) |
| 27 | ELP 492 | Experiential Learning | 20 (0+20) |
| | | **Total** | **94(34+60)** |

## BASIC SCIENCES AND HUMANITIES

| | | | |
|---|---|---|---|
| 1. | Biochem. 101 | Introduction to Biochemistry | 3(2+1) |
| 2. | Bot. 104 | Fundamentals of Crop Physiology | 2(1+1) |
| 3. | Econ. 201 | Economics And Marketing | 3(2+1) |
| 4. | Eng. 101 | General English | 2(1+1) |
| 5. | Eng. 201 | Communication Skills and Personality Development | 2(1+1) |
| 6. | Mgt. 201 | Entrepreneurship Development and Business Management | 3(2+1) |
| 7. | Micro 102 | Elementary Microbiology | 3(2+1) |
| 8. | Stat. 206 | Basic Statistics | 2(1+1) |
| | | **Total** | **20 (12+8)** |

## AGRICULTURAL ENGINEERING AND INFORMATION TECHNOLOGY

| | | | |
|---|---|---|---|
| 1. | CSE 101 | Information and Communication Technology in Agriculture | 3(1+2) |
| 2. | FMP 205 | Farm Power and Machinery for Horticulture | 2(1+1) |
| 3. | SWE 205 | Horticulture Crops | 2(1+1) |
| 4. | SWE 305 | Precision Farming and Protected Cultivation | 3(2+1) |
| | | **Total** | **10(5+5)** |

## AGRICULTURE

| | | | |
|---|---|---|---|
| 1. | Agromet. 102 | Introductory Agrometeorology and Climate Change | 2(1+1) |
| 2. | Agron. 104 | Introduction to Major Field Crops | 3(2+1) |
| 3. | Agron. 206 | Weed Management in Horticultural Crops | 2(1+1) |
| 4. | Agron. 304 | Principles of Organic Farming | 2(1+1) |
| 5. | Agron. 307 | Medicinal, Spices and Aromatic Crops | 3(2+1) |
| 6. | Biotech. 206 | Fundamentals of Plant Biotechnology | 3(2+1) |
| 7. | Ent. 302 | Management of Beneficial Insects | 3(2+1) |
| 8. | Ent. 303 | Insect-pests of Horticultural crops and their management | 3(2+1) |
| 9. | Env. 101 | Environmental Studies and Disaster Management | 2(2+0) |
| 10. | Ext. 201 | Fundamentals of Agricultural Extension Education | 3(2+1) |
| 11. | FT 201 | Fundamentals of Food Processing | 2(1+1) |
| 12. | PBG 102 | Fundamentals of Genetics | 3(2+1) |
| 13. | PBG 201 | Fundamentals of Plant Breeding | 3(2+1) |
| 14. | Pl. Path. 104 | Introductory Plant Pathology | 3(2+1) |
| 15. | Pl. Path. 304 | Diseases of Horticultural Crops and Their Management –I | 4(3+1) |
| 16. | Soils 101 | Fundamentals of Soil Science | 3(2+1) |
| 17. | Soils 301 | Manures, Fertilizers and Soil Fertility Management | 3(2+1) |
| 18. | Soils 304 | Soil Water and Plant Analysis | 2(1+1) |
| 19. | Optional Course-1 | | 2+1/1+2 |

| | | | |
|---|---|---|---|
| 20. | Optional Course-2 | | 2+1/1+2 |
| | RAWE 401 | General Orientation and On-campus Training | 1(0+1) |
| | RAWE 402 | Village Attachment | 8(0+8) |
| | RAWE 403 | KVK and Research Station Attachment | 5(0+5) |
| | RAWE 404 | Plant Clinic | 2(0+2) |
| | AIA 491 | Agro-Industrial Attachment | 4( 0+4) |
| | ELP 492 | Experiential Learning Modules | 20(0+20) |
| | Educational Tour Compulsory Educational Tour | | 0+2(NC) |
| | | **Total** | **40(0+40)** |

## COMMUNITY SCIENCE

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1(1+0) |
| 2 | FN 205 | Fundamental of Food and Nutrition | 2(1+1) |

## NCC/NSO/NSS

| | | | |
|---|---|---|---|
| 1. | NCC/NSO/NSS | (SEM-I) | 1(0 + 1) (NC) |
| 2. | NCC/NSO/NSS | (SEM-II) | 1(0 + 1) (NC) |
| 3. | NCC/NSO/NSS | (SEM-III) | 1(0 + 1) (NC) |
| 4. | NCC/NSO/NSS | (SEM-IV) | 1(0 + 1) (NC) |

Total credit hours requirement for B.Sc.(Hons.)Agri.Programme:179+2NC*+4NC**=185

*NC Educational Tour

**NC NCC/NSS/NSO

# SEMESTER- WISE STUDY PROGRAMME OF
# B.Sc. (Hons) Horti 4 YEAR PROGRAMME

## FIRST YEAR

| | SEM I | | | SEM II | |
|---|---|---|---|---|---|
| 1. | Hort. 101 | 3 (2+1) | 1. | Hort. 102 | 3 (2+1) |
| 2. | Flori. 101 | 2 (1+1) | 2. | Hort. 104 | 3 (2+1) |
| 3. | Bot. 104 | 2 (1+1) | 3. | Veg. 101 | 3 (2+1) |
| 4. | Soils 101 | 3 (2+1) | 4. | Agron. 104 | 3 (2+1) |
| 5. | Biochem. 101 | 3 (2+1) | 5. | Env. 101 | 2 (2+0) |
| 6. | PBG 102 | 3 (2+1) | 6. | Pl. Path. 104 | 3 (2+1) |
| 7. | Micro. 102 | 3 (2+1) | 7. | Agromet. 102 | 2 (1+1) |
| 8. | HDFS 106 | 1 (1+0) | 8. | Flori. 102 | 2 (1+1) |
| 9. | Bio. 102/Math 103 | 2 (1+1)/2(2+0) | 9. | CSE 101 | 3 (1+2) |
| 10. | Eng. 101 | 2 (1+1) | 10. | NSS/NCC/NSO | 1 (0+1) (NC) |
| 11. | NSS/NCC/NSO | 1 (0+1) (NC) | | | |
| | | **24+1(NC)=25** | | | **24+1 (NC)=25** |

Remedial Course Bio 102 for Non Medical stream and Math 103 for Medical stream students

## SECOND YEAR

| | SEM III | | | SEM IV | |
|---|---|---|---|---|---|
| 1. | Hort. 205 | 3 (2+1) | 1. | Veg. 204 | 3 (2+1) |
| 2. | Econ. 201 | 3 (2+1) | 2. | Hort. 204 | 3 (2+1) |
| 3. | Veg. 201 | 3 (2+1) | 3. | Hort. 206 | 2 (1+1) |
| 4 | PBG 201 | 3 (2+1) | 4. | SWE 205 | 2 (1+1) |
| 5. | Flori. 201 | 3 (2+1) | 5. | Agron. 206 | 2 (1+1) |
| 6. | Eng. 201 | 2 (1+1) | 6. | FN 205 | 2 (1+1) |
| 7. | Ext. 201 | 3 (2+1) | 7. | FT 201 | 2 (1+1) |
| 8. | FMP 203 | 2 (1+1) | 8. | Mgt. 201 | 3 (2+1) |
| 9. | NSS/NCC/NSO | 1 (0+1) (NC) | 9. | Biotech. 206 | 3 (2+1) |
| | | | 10. | Stat. 206 | 2 (1+1) |
| | | | 11. | NSS/NCC/NSO | 1 (0+1) (NC) |
| | | **23+1(NC)=24** | | **24 +1 (NC) = 25** | |

## THIRD YEAR

| | SEM V | | | SEM VI | |
|---|---|---|---|---|---|
| 1. | Forst. 301 | 2 (1+1) | 1. | Hort. 304 | 3 (2+1) |
| 2. | Hort. 303 | 3 (2+1) | 2. | Hort. 306 | 2 (1+1) |
| 3. | Hort. 305 | 3 (2+1) | 3. | Veg. 304 | 3 (2+1) |
| 4. | Veg. 305 | 2 (1+1) | 4. | Flori. 302 | 3 (2+1) |
| 5. | Agron. 307 | 3 (2+1) | 5. | Soils 304 | 2 (1+1) |
| 6. | Ent. 303 | 3 (2+1) | 6. | Pl. Path. 304 | 4 (3+1) |
| 7. | SWE 305 | 3 (2+1) | 7. | Agron. 304 | 2 (1+1) |
| 8. | Soils 301 | 3 (2+1) | 8. | Ent. 302 | 3 (2+1) |
| 9. | Edu. Tour | 0 + 2 (NC) | | | |
| | | **22+ 2 (NC) = 24** | | | **22** |

## FOURTH YEAR

| | SEM VII | | | SEM VIII | |
|---|---|---|---|---|---|
| 1. | RAWE 401 | 1 (0+1) | 1. | ELP 492 | 20 (0+20) |
| 2. | RAWE 402 | 8 (0+8) | | | |
| 3. | RAWE 403 | 5 (0+5) | | | |
| 4. | RAWE 404 | 2 (0+2) | | | |
| 5. | Hort. 491 / Veg. 491 / Flori. 491 / Forst. 491 | 4 (0+4) | | | |
| | | **20 (0+20)** | | | **20 (0+20)** |

## Agro-Industrial Attachment

| Sr. No | Course No. | Course Title | Credit Hours | Modules |
|---|---|---|---|---|
| 1 | *Hort. 491 | Agro-industrial Attachment | 0+4 | (i) Commercial Fruit Nurseries<br>(ii) Farms of Progressive Fruit Growers<br>(iii) Fruit Processing Plants |
| 2 | *Veg. 491 | Agro-industrial Attachment | 0+4 | (i) Commercial Vegetable Nurseries<br>(ii) Farms of Progressive Vegetable Growers<br>(iii) Vegetable Processing Plants |
| 3 | *Flori. 491 | Agro-industrial Attachment | 0+4 | (i) Commercial Flower Nurseries<br>(ii Flower Seed Production and Landscaping Units |
| 4 | *Forst. 491 | Agro-industrial Attachment | 0+4 | (i) Forest based Industry<br>(ii)High-tech Nursery(Tree Planting Stock Production) |

## Experiential Learning Modules

| | Course No. | Course Title | Credit Hours |
|---|---|---|---|
| 1 | Hort. 492 | Experiential Learning in Commercial Horticulture | |
| 2 | Veg. 492 | Experiential Learning in Commercial Vegetable Production | |
| 3 | Flori. 492 | Experiential Learning in Commercial Floriculture and Landscaping | |
| 4 | Forst. 492 | Experiential Learning in Nursery Production of Agro-forestry Trees | |
| | | **Total** | **20 (0+20)** |

## Semester Wise Total Credit Hours

| Semester | Credit Hours |
|---|---|
| I | 21 (13+8)+ 2(1/2+1/0)+1(NC**)=24 |
| II | 24(15+9)+1(NC**)=25 |
| III | 23(15+9)+1(NC**)=24 |
| IV | 24(14+10)+1(NC**)=25 |
| V | 22(14+8)+2(NC*)=24 |
| VI | 22(14+8) |
| VII | 20(0+20) |
| VIII | 20+(0+20) |
| **TOTAL** | **179+2NC*+4NC**=185** |

*NC Educational Tour

**NC NCC/NSS/NSO

SECTION IX

# FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

## General Information

## Disciplines

- Farm Machinery and Power Engineering
- Processing and Food Engineering
- Soil and Water Engineering
  - (A) Irrigation and Drainage Engineering
  - (B) Soil and Water Conservation Engineering
  - (C) Remote Sensing and GIS
- Civil Engineering
- Mechanical Engineering
- Renewable Energy Engineering
- Electrical Engineering and Information Technology
- Electrical Engineering
- Computer Science and Engineering
- Information Technology
- Course curriculum for B.Tech. (Agri. Engg.) 4 year programme

# COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

The College of Agricultural Engineering and Technology (formerly the College of Agricultural Engineering) was established in 1964 as one of the constituent colleges of the Punjab Agricultural University, Ludhiana with the objectives of imparting education, to carry out multi- faceted research and to disseminate information related to technologies thus developed to the stake holders related to the area of Agricultural Engineering. The College has also played a leading role in solving the problems of farmers and industry by undertaking problem-oriented research and speedy transfer of technology. The College has maintained close liaison with different State Government departments and agencies for effective dissemination of new knowledge.

The College got international recognition when a Centre of Advanced Studies in Postgraduate Teaching and Research was established by the United Nations Development Programme (UNDP) / Indian Council of Agricultural Research (ICAR) in 1974. Subsequently, a Centre of Advanced Studies on Energy Management in Agriculture was established with major support from the Food and Agricultural Organization of the UNO (FAO)/ UNDP/ICAR in 1983, and the School of Energy Studies for Agriculture was established. The ICAR also sanctioned the establishment of a Centre for Advanced Studies in the discipline of Farm Power and Machinery in 1997. The College was conferred an award by the Federation of Indian Chambers of Commerce and Industry in 1975 for its contributions. The College gets its major budgetary support from the ICAR and the Punjab Government. Several research projects are underway with the financial support from the World Bank, Department of Science and Technology, Govt. of India, Sir Rattan Tata Trust and several non-government organizations.

The College started its undergraduate programme B.Sc. (Agril. Engg. and Tech.), subsequently changed to B.Tech. (Agril. Engg.) in 1965 by following the trimester system (and again subsequently switching to the semester system) of instructions and the first batch was graduated in 1969. The undergraduate teaching was initially handled by the Departments of Agricultural Engineering, Civil Engineering, Electrical Engineering and Mechanical Engineering. The Department of Agricultural Engineering was trifurcated in 1974 into the Departments of Farm Power and Machinery (now Farm Machinery and Power Engineering), Soil and Water Engineering, Processing and Agricultural Structures (now Processing and Food Engineering). The School of Information Technology (SIT), established in 2009 at PAU was made an integral part of the College in 2010. After merging the Department of Electrical Engineering and SIT, the School of Electrical Engineering and Information Technology (SEEIT) was created in 2012. The Training & Placement Unit in the College is well established which takes care of the student trainings, jobs and career oriented activities. The Placement Cell of the College has excellent track-record resulting in the employment of the students by several multi-national companies and government departments. The Farm Machinery Testing Centre is also functional and tests the manufactured machinery as per BIS standards catering to the services of agricultural manufacturers and entrepreneurs. The College has state of the art infrastructure and well equipped undergraduate and postgraduate laboratories. The Alumni Association of the College is highly active and its inter-active website is functional within the website of the Punjab Agricultural University, Ludhiana.

With the growth of the College, M.Tech. and Ph.D. programmes were started in different disciplines keeping in view the employment needs of the students and beneficiaries like industry, public sector and farmers of the State. The M.Tech. programme in Remote Sensing and GIS was started in collaboration with Punjab Remote Sensing Centre, Punjab from the academic session 2012-13. The B.Tech. (Agril. Engg.) admission is made on the basis of JEE (Mains) conducted by the CBSE, where as the PG admission is made on the basis of merit list prepared through written test and interview at PAU level and PG test conducted by ICAR. The undergraduate (UG) and PG programmes have duly been recognized by ICAR. The revision of course curricula is a continuous process. The revised B.Tech. (Agril. Engg.) programme in the light of the recommendations of the Vth Deans' Committee of ICAR has been adopted from the session 2016-2017. The model curricula and the revised/restructured PG programmes as per the recommendations of the National Core Group (ICAR) were introduced in the academic session 2010-2011. The curricula have sufficient components of engineering disciplines, basic sciences, agricultural sciences, practical and hands on training. The newly included student ready training programme as per ICAR guidelines has also been introduced and operational in the College.

The student evaluation criteria constitute internal and external components and a system of Credit Point Average on a 10 point-scale basis is followed for grading of students. The College had several short duration student and teacher exchange programmes with two Russian Universities till 2015-16. The College

has several MoUs and Collaborative research projects with overseas universities in almost all disciplines of Agricultural Engineering. The College of Agricultural Engineering and Technology has developed several innovative engineering technologies which have promoted farm mechanization, precision farming, efficient soil and water management, controlled environment agriculture, efficient post harvest handling of produce/products and adoption of renewable energy technologies particularly solar energy, and paddy straw management in the state and country during its existence of more than five decades. The faculty of the College has distinguished itself to its contributions in the field of teaching, research and extension by winning several prestigious awards at national and International levels such as Rafi Ahmed Kidwai Memorial Prize, Jawahar Lal Nehru Award, and Stanford University's most highly cited scientist award etc.

# FARM MACHINERY AND POWER ENGINEERING

## PROGRAMMES

**M.Tech.**

**Ph.D.**

## COURSE REQUIREMENTS

### M.Tech.

| | |
|---|---|
| Field of Specialization | Farm Machinery and Power Engineering |
| Required Courses | FMPE-501, FMPE-502, FMPE-503, FMPE-507 |
| Supporting Courses | Stat.-502, or courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problems. |
| Minor Field | Mechanical Engineering, Renewable Energy Engineering, Computer Science and Engineering, Electrical Engineering, Mathematics and Statistics, Processing and Food Engineering or any other as approved by the Dean Postgraduate Studies |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

**Ph.D.**

| | |
|---|---|
| Field of Specialization | Farm Machinery and Power Engineering |
| Required Courses | FMPE-601, FMPE-612 |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problems. |
| Minor Field | Mechanical Engineering, Renewable Energy Engineering, Computer Science and Engineering, Electrical Engineering, Mathematics and Statistics, Processing and Food Engineering or any other as approved by the Dean Postgraduate Studies |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**FMP 51 Farm Machinery & Micro Irrigation** **1+1** **Sem. I**

**(For students of Diploma in Agriculture)**

Familiarization with sources of power used at the farm. Different systems of tractors, types and selection. Primary and secondary tillage implements. Implements for intercultural operation, seed drills, paddy transplanters, their calibration. Plant protection, harvesting and threshing equipment. Precision farming equipment like laser land leveller, Maintenance of agricultural machinery. Safety on the farm and on the road. Mandatory and cautionary signs. Log books. Drip and sprinkler irrigation Fertigation. Use of solar power in agriculture.

**Practical:** Various systems of tractor. Study of various parts of agricultural machines along with their functions. Tractor driving and operation of agricultural machines and hauling operation. Repair and maintenance of various machines including sprayers and dusters, their adjustment and performance. Calibration of seed drill/ planter. Visit to field micro-irrigation & solar power units.

**FMP 102 Farm Machinery and Power** **1+1** **Sem. II**

**(For students of College of Agriculture)**

Status of Farm Power in India, Sources of Farm Power, Internal Combustion (IC) engines and its working, IC engine terminology, comparison of two and four stroke cycle engines, Study of IC engine systems: aircleaning, fuel, lubrication, cooling etc. and solved problems. Familiarization with tractor power transmission systems. Tractor types. Cost analysis of tractor power and attached implements. Familiarization with Primary and Secondary Tillage implements. Implements for hill agriculture. Familiarization with sowing and planting equipment, calibration of a seed drill and problem solving Familiarizations with transplanters. Familiarization with equipment for plant protection and intercultural operations. Familiarization with harvesting and threshing equipment.

**Practical:** Study of different components of IC engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow . Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter. Familiarization with different types of sprayers and dusters Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

**FMP 201 Tractor and Farm Machinery Operation** **0+1** **Sem. I**

Familiarization with different makes and models of agricultural tractors. Identification of various functional systems including air supply, fuel, cooling, transmission, steering and hydraulic systems. Maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Practice of driving a tractor and with tillage tools (Primary/Secondary tillage implements) and their adjustment in the field. Field patterns while operating a tillage implement. Hitching and de-hitching of mounted and trailed type implements to the tractor. Practice for driving of a trailed type trolley: forward and in reverse direction.

**FMP 203 Farm Machinery and Equipment-I** **2+1** **Sem. II**

Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and efficiencies. Calculations for economics of machinery usage. Comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its

classification. Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary, secondary, rotary, deep and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Identification of major functional components of tillage machines: mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, rotavator, laser land leveler. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Identification of major functional components of seed drills, no-till drills, strip-till drills, happy seeder, planters, bed-planters and paddy transplanters. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to materials used in construction of farm machines. Introduction to heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application.

**Practical:** Familiarization with different farm implements and tools. Study of hitching systems, Problems on machinery management. Primary and secondary tillage machinery: construction, operation, adjustments, calculations of power and draft requirements. Sowing and planting equipment: construction, types, calculation for calibration and adjustments. Transplanters: paddy, vegetable etc. Identification of materials of construction in agricultural machinery and study of material properties. Heat treatment processes subjected to critical components of agricultural machinery.

**FMP 205 Farm Machinery and Power for Horticultural Crops 1+1 Sem. I**

**(For students of College of Horticulture and Forestry)**

Basic concepts of various forms of energy, unit and dimensions of force energy and power, calculations with realistic examples. Tractors, power tillers and their types and uses. Introduction to IC engines: Basic principles of operation of compression ignition and spark ignition engines; two stroke and four stroke engines; cooling and lubrication systems; power transmission systems; broad understanding of performance and efficiency. Electric motors: Basic working, types, and construction. Tillage: objectives, method of ploughing. Primary tillage implements: construction and functions of improved indigenous ploughs, mould board ploughs, disc and rotary ploughs, offset rotavators. Secondary tillage implements: construction and functions of cultivators, harrows, levelers, ridgers and bund formers. Post-hole digger. Introduction to planting and transplanting equipment's: potato planters, small seed planters, nursery sowing machinery, vegetable transplanters, plastic mulch and drip laying machinery. Introduction to inter-culture machinery, aero-blast sprayers, electrostatic sprayers, sprayer calibration and safety features, shrub cutters, pick positioner; grafting, pruning and training tools and equipment's; sweep, rotary weeders, tractor operated pruners. Crop harvesting equipment's: potato diggers, fruit pluckers, and seed extraction machines.

**Practical:** Calculation on force, power and energy. IC engines – showing the components of dismantled engines. Primary and secondary tillage implements: hitching, adjustments and operations. Operation of post hole digger, vegetable transplanters; plastic mulch and drip laying machinery. Operation of interculture equipment's including offset rotavator in orchards. Plant protection equipment's, calibration, calculation of dilution ratio and operation. Operation of power weeder, shrub cutter; crop harvesting equipment's and seed extraction machines.

**FMP 207 Farm Machinery and Power for Managers 1+1 Sem. I**

**(For students of College of Basic Sciences and Humanities)**

Status of Farm Power in India, Sources of Farm Power. Introduction to tractors and types of I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines. Engine Terminology. Study of different components of IC engine, IC engine terminology and solved problems, Familiarization with different systems of IC. Engines I.C. engine systems: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor, Numerical problems on engine power, air fuel ratio etc. Familiarization with Tractor Power transmission system: clutch, gear box, differential and final drive of a tractor, Tractor types, Cost analysis of tractor power and attached implement, Farm Machinery: Machinery usage terminology, Tractor and Machinery management techniques. Cost analysis of machinery usage, Break-even analysis, Purchase Vs custom hiring decision making. Familiarization with Primary and Secondary Tillage implement, Implements for hill agriculture, implement for intercultural

operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

**Practical:** Study of different components of I.C. engine. To study air cleaning and cooling system of engine. Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of tractor engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow. Familiarization with seed cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter. Familiarization with different types of sprayers and dusters Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

**FMP 302 Tractor and Automotive Engines** **2+1** **Sem. I**

Study of sources of farm power: conventional and non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Mechanical, thermal and volumetric efficiencies. Engine components, their construction, operating principles and functions. Engine strokes, 2- stroke and 4-stroke engine cycles. CI and SI engines. Engine valve systems, valve mechanism, valve timing diagram and valve clearance adjustment. Cam profile, valve lift and valve opening area. Importance of air cleaning system. Types of air cleaners and performance characteristics of various air cleaners. Fuel supply system. Fuels, properties of fuels, calculation of air-fuel ratio. Tests on fuel for SI and CI engines. Detonation and knocking in IC engines. Carburetion system, carburetors and their main functional components. Fuel injection system: injection pump, their types, working principles. Fuel injector nozzles: their types and working principle. Engine governing: need of governors, governor types and governor characteristics. Lubrication system: need, types, functional components. Lubricants: physical properties, additives and their application. Engine cooling system: need, cooling methods and main functional components. Thermostat valves. Additives in the coolant. Radiator efficiency. Ignition system of SI engines. Electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing.

**Practical:** Introduction to different systems of CI engines: engine parts and functions, working principles etc. Study of valve system: construction and adjustments. Determination of physical properties of oil and fuels. Air cleaning system. Fuel supply system of SI engine. Diesel injection system & timing. Cooling system, fan performance, thermostat and radiator performance evaluation. Part load efficiencies and governing. Lubricating system. Starting and electrical system. Ignition system. Tractor engine heat balance and engine performance curves. Visit to engine manufacturer/ assembler/ spare parts agency.

**FMP 306 Farm Machinery and Equipment-II** **2+1** **Sem. I**

Introduction to plant protection equipment: sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calibration of sprayers. Introduction to intercultural equipment. Study of weeders: functional requirements, types and main components and functional requirements. Familiarization of fertilizer application equipment. Harvesting operation: terminology, principle of cutting and harvesting methods. Mowers: types, constructional details, working and adjustments. Study of shear type harvesting devices: cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Reapers, binders and windrowers: principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning and baling and calculation of moisture content of hay. Introduction to threshing systems: manual and mechanical systems. Types of threshing drums and their applications. Types of threshers: tangential and axial flow, their constructional details and cleaning systems. Factors affecting thresher performance. Grain combines: terminology, classification, material flow and computation of grain losses. Study of combine troubles and troubleshooting. Chaff cutters and capacity calculations. Straw choppers and combines: working principle and constructional details. Study of root crop diggers: principle of operation, blade adjustment and approach angle, calculation of material handled. Potato and groundnut diggers. Cotton harvesting machinery: different mechanisms, pickers and strippers, functional

components. Study of maize de-husking cum shelling machinery and harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

**Practical:** Familiarization with plant protection and intercultural equipment. Study of sprayers, types and functional components. Dusters, types and functional components. Calculations for chemical application rates. Nozzle types and spray pattern using patternator. Familiarization with manual and powered weeding equipment and identification of functional components. Fertilizer application equipment including manure spreaders and fertilizer broadcasters. Various types of mowers, reaper and reaper binder. Functional components of mowers and reapers. Familiarization with threshing mechanisms and cleaning systems. Calculations of losses in threshers. Familiarization with functional units of grain combines and their types. Calculations for grain losses in combines. Root crop diggers and familiarization with the functional units and attachments. Familiarization with the working of cotton and maize harvesters. Familiarization with vegetable and fruit harvesters.

**FMP 307 Tractor Systems and Controls** **2+1** **Sem. II**

Study for need of transmission system in a tractor. Transmission system: types, major functional systems. Clutch: need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Gear box: gearing theory, principle of operation, types, functional requirements and calculation for speed ratio. Differential system: need, functional components, construction, calculation for speed reduction. Need for a final drive. Brake system: types, principle of operation, construction, calculation for braking torque. Steering system: requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Hydraulic system in a tractor: principle of operation, types, main functional components, functional requirements. Familiarization with the hydraulic system adjustments and ADDC. Tractor power outlets: PTO, PTO standards, types and functional requirements. Introduction to traction and traction terminology. Theoretical calculations of shear force and rolling resistance on traction device. Wheels and tyres: solid and pneumatic tyres, construction and specifications. Study of traction aids. Tractor mechanics: forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing deciphering of codes.

**Practical:** Introduction to transmission systems and components. Study of clutch functioning, parts and design problem on clutch system. Types of gear boxes, calculation of speed ratios, design problems on gear box. Differential, final drive and planetary gears. Brake systems and some design problems. Steering geometry and adjustments. Hydraulic systems in a tractor, hydraulic trainer and some design problems. Appraisal of various controls in different makes of tractors in relation to anthropometric measurements. Determination of location of CG of a tractor. Moment of Inertia of a tractor. Traction performance of a tractor wheel.

**FMP 311 Tractor and Farm Machinery Maintenance** **0+1** **Sem. II**

Introduction to tractor maintenance: precautionary and break-down maintenance. Tractor starting with low battery charge. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 50, 100, 250, 500 and 1000 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements: adjustment of functional parameters in tillage implements. Replacement of broken and worn-out components in tillage implements. Replacement of furrow openers and blades of rotavators. Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Setting of workshop for agricultural machinery.

## Elective Courses

**FMP 411 Tractor Design and Testing** **2+1** **Sem. II**

Procedure for design and development of agricultural tractor. Study of parameters for design of balanced tractor for stability and weight distribution. Traction theory. Hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multiple disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman and hydraulic steering. Study of special design features of tractor engines and their selection: cylinder, piston, piston pin, crankshaft etc. Design of seat and controls of an agricultural tractor. Tractor testing.

**Practical:** Design problems of tractor clutch system: single and multiple discs. Design of gear box: constant mesh, synchro-mesh and variable speed drive. Selection of tractor tires and problem solving. Problems on design of governor. Design and selection of hydraulic pump. Engine testing as per BIS code. Drawbar performance in the lab. PTO test and measure the tractor power in the lab/field. Determining the turning space, turning radius and brake test. Hydraulic pump performance test. Air cleaner and noise measurement test. Visit to tractor testing center/industry.

**FMP 412 Farm Machinery Design and Production** **2+1** **Sem. II**

Introduction to design parameters of agricultural machines and design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of agricultural machinery. Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, electro-discharge machining (EDM). Heat treatment of steels including pack carburizing, shot-peening process etc. Limits, fits and tolerances. Jigs and fixtures. Industrial lay-out planning. Quality production management, reliability. Economics of process selection. Familiarization with project report.

**Practical:** Familiarization with different design aspects of farm machinery and selected components. Solving design problems on farm machines and equipment. Jigs and fixtures: study in relation to agricultural machinery. Fits, tolerances and limits. Layout planning of a small scale industry. Problems on economics of process selection. Preparation of a project report. Case study for manufacturing of simple agricultural machinery. Visits to agricultural machinery and tractor manufacturing industry.

**FMP 413 Mechanics of Tillage and Traction** **2+1** **Sem. II**

Introduction to mechanics of tillage tools. Engineering properties of soil: principles and concepts, stress strain relationship. Design of tillage tools: principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation. Introduction to traction and mechanics, off road traction and mobility, traction models. Traction improvements: tyre size, tyre lug geometry and their effects, tyre testing. Soil compaction and plant growth. Variability and application of GIS in soil dynamics.

**Practical**: Measurement of static and dynamic soil parameters related to tillage, puddling and floatation. Draft for passive, rotary and oscillating tools. Slip and sinkage under dry and wet soil conditions. Load and fuel consumption for different farm operations. Weight transfer and tractor loading including placement and traction aids. Studies on tyres, tracks and treads under different conditions, soil compaction and number of operations.

**FMP 414 Ergonomics and Safety** **2+1** **Sem. II**

Human factors in system development: concept of systems, basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Introduction to biomechanics of motion, types and range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Application of concept of ergonomics in farm machinery. Dangerous machine (Regulation) act,

Rehabilitation and compensation to accident victims, safety gadgets for spraying, threshing, chaff cutting and tractor & trailer operation etc.

**Practical:** Calibration of the subject in the laboratory using bi-cycle ergo-meter. Study and calibration of the subject in the laboratory using mechanical treadmill. Use of respiration gas meter from human energy point of view. Use of heart rate monitor. Study of general fatigue of the subject using blink ratio method. Familiarization to electro-myograph equipment, anthropometric measurements of a selected subject. Optimum work space layout and locations of controls for different tractors. Familiarization with the noise and vibration equipment. Familiarization with safety gadgets for various farm machines.

**FMP 415 Hydraulic Drives and Controls** **2+1** **Sem. II**

Hydraulic basics: Pascal's law, flow, energy, work, and power. Hydraulic systems: color-coding, reservoirs, strainers and filters, filtering material and elements, accumulators, pressure gauges and volume meters. Hydraulic circuits, fittings and connectors. Pumps: classifications, operation, performance, displacement. Design of gear, vane and piston pumps. Hydraulic actuators, cylinders, construction and applications, maintenance, hydraulic motors. Valves: pressure, directional and flow-control valves, valve installation, valve failures and remedies, valve assembly. Hydraulic circuit diagrams and troubleshooting, United States of American Standards Institute (USASI) graphical symbols. Tractor hydraulics, nudging system, ADDC. Pneumatics: air services, logic units, fail safe and safety systems. Robotics: Application of hydraulic and pneumatic drives in agricultural systems, Introduction about programmable logic controls (PLCs).

**Practical:** Introduction to hydraulic systems. Study of hydraulic pumps and actuators. Study of hydraulic motors, valves, colour codes and circuits. Building simple hydraulic circuits. Hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture. Use of hydraulics and pneumatics for robotics.

**FMP 416 Precision Agriculture and System Management** **2+1** **Sem. II**

Precision Agriculture: need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture: laser guided land levelers, precise sowing and planting machines, variable rate sprayers, yield monitoring system and moisture sensor for grain combines etc. Introduction to GIS based precision agriculture and its applications. Introduction todifferent soil and plant sensors. Application of GPS based navigators and sensors for data handling in agricultural machinery management. System concept and approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management

**Practical**: Familiarization with precision agriculture problems and issues. Familiarization with various machines for resource conservation. Operation of different GIS software's for data management. Field data collection using GPS based navigators, yield monitors, moisture sensors, soil and plant sensors etc. Solving problems related to various capacities, pattern efficiency, system limitation, etc. Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.

**FMP 417 Machinery for Crop Residue and Fodder Management** **2+1** **Sem. II**

Introduction to biomass management, biomass resource assessment techniques, supply chains. Processing of paddy straw: densification, extrusion process, pellets, mills and cubes. Baling: machines, classification and uses. Residue management for surface mulch and incorporation: paddy straw choppers and spreaders, straw managing system as an attachment to combine harvester, mulch seeder, forage chopper cum loader etc. Processing of straw/fodder for animal use, agricultural and horticultural use, cushioning material for fruits and vegetables, mulching and composting, paper and cardboard manufacturing, straw as a fuel.

**Practical**: Familiarization with different straw management techniques: on-farm and off- farm uses of straw, collection, loading and transport equipment's for unbruised loose straw. Briquetting machine and preparation of briquettes. Straw baler and making of bales in the field. Straw/ fodder chopping machines, straw/mulching and incorporating machinery. Machinery requirement for baling forage crops for silage.

**FMP 418 Farm Power and Machinery Management** **2+1** **Sem. II**

The role of mechanization and its relationship to productivity, employment, social and technological change. Performance and power analysis. Cost analysis of machinery: fixed and variable costs, effect of inflation on cost. Selection of optimum machinery and replacement criteria. Break-even analysis. Reliability and cash flow problems. Mechanization planning; case studies of agricultural mechanization in India.

**Practical:** Solving problems related to various capacities, pattern efficiency, system limitation, power requirement and other operational parameters. Problems related to cost analysis and inflation. Problems related to selection of equipment, replacement, break- even analysis, etc. Presentation of seminar on topic assigned related to farm machinery management. Design of farm mechanization plan for different farm size and cropping pattern.

## Postgraduate Courses

**FMPE-501 Soil Dynamics in Tillage and Traction** **2+1** **Sem. I**

**Unit I** Characterization of state of stress in a point: Derivation, representation by Mohr's Circle. Coulomb's law of friction and cohesion. Measurement of soil resistance properties: Direct shear box, torsion shear apparatus, tri-axial apparatus. Soil behaviour considerations: Soil water pressure and movement. Critical state soil mechanics: Soil stress-strain behaviour, shear rate effects.

**Unit II** Soil cutting forces: The universal earthmoving equation, two dimensional cases, smooth vertical blade, smooth and rough raked blades in cohesive soil, unconstrained tool to soil adhesion. The shape of failure surfaces. Hettiaratchi's calculations, effect of soil weight. Soil cutting force by method of trial wedges.

**Unit III** Extension of theory to three dimension: Hettiaratchi, Reece-Godwin and Spoor. Three dimensional wedges: McKyes and Ali, Grisso models. Dynamic effect: Inertial forces, change in soil strength. Concept of critical depth. Complex tool shapes: Curved tools-shank and foot tools-mould board plough. Soil Loosening and manipulation: Measurement of soil loosening and its efficiency. Draft force efficiency: Loosening and pulverization efficiency. Soil mixing and inversion: Soil properties, tool shape, tool speed and tool spacing.

**Unit IV** Traction devices: Tyres, type, size, selection mechanics of traction devices. Maximum traction force: Soil deformation and slip, estimation of contact areas. Sinkage in soil: Rolling resistance, Bekker's formulae, McKyes formulae. Soil compaction by agricultural vehicles and machines.

**Practical** : Measurements of soil shear strength by in-situ shear box apparatus and soil friction by friction plate. Measuring cone penetrometer resistance and working out tractive coefficients for tyres. Measurement of in-situ shear strength of soil by torsional vane shear apparatus. Solving problems on stress in soil. Solving problems on soil properties. Solving problems of tool forces. Problems on tillage tool forces, wheel slippage, tyre deflection, design and performance of traction devices.

**FMPE-502 Testing and Evaluation of Agriculture Equipment** **2+1** **Sem. I**

**Unit I** Importance and significance of testing and types of testing. Test equipment, usage and limitations. Test procedures and various test codes: National and International.

**Unit II** Laboratory and field testing of tillage and sowing machinery: Sub-soiler, laser land leveler, mould board Plough, disc plough, rotavator, cultivator, disc harrow, seed cum fertilizer drill and planter.

**Unit III** Laboratory and field testing of manual and power operated intercultural machinery and plant protection machine.

**Unit IV** Laboratory and field testing of reaper, thresher and chaff cutter.

**Unit V** Laboratory and field testing of straw combine and combine harvester. Review and interpretation of test reports. Importance and need of standardization of components of agricultural equipment.

**Practical** : Laboratory and field testing of selected farm equipment: Tillage, sowing and planting. Material testing of critical components. Accelerated testing of fast wearing components.

**FMPE-503 Ergonomics and Safety in Farm Operations** **2+1** **Sem. I**

**Unit I** Description of human-machine systems. Ergonomics and its areas of application in the work system. History of ergonomics. Modern ergonomics.

**Unit II** Anthropometry: Its role in daily life, principles in workspace and equipment design, design of manual handling tasks and application in equipment design. Human postures: Postural stress and its role in design of farm machinery.

**Unit III** Human factors in tractor seat design: Entry system, controls, shape, colour coding, dial and indicators. Modern technology for comfort in driving places.

**Unit IV** Physiological parameters: Psychological and mental stresses and their measurement techniques. Human energy expenditure: Calibration of subjects, human workload and its assessment.

**Unit V** Safety considerations and operators protective gadgets in farm operations. Standards/codes for tractors and agricultural machinery safety.

**Practical** : Identifying role of ergonomics in our daily life. Measurement of anthropometric dimensions of agricultural workers and establishing relationship between them. Determination of human requirements for field operation with manually operated equipment. Assessment of psychological/general load for specific agricultural operations. Calibration of human subject on bicycle ergometer and/ or treadmill for its energy output and physiological parameters like heart rate, oxygen consumption rate under laboratory conditions. Case studies of agricultural accidents and safety measure.

**FMPE-504 Design of Tractor Systems** **2+1** **Sem. II**

**Unit I** Design and types, research, development, design procedure, technical specifications of tractors, modern trends in tractor design and development, special design features of tractors in relation to Indian agriculture.

**Unit II** Engine related terminology. Selection of stroke-bore ratio. Design of engine components; Piston, connecting rod, cylinder, cylinder head, crank shaft etc.

**Unit III** Design of tractor systems like clutch, gearbox, steering, steering geometry, turning force, hydraulic system & hitching, chassis, operator's seat, work-place area and controls. Tire selection, aspect ratio etc.

**Unit IV** Mechanics of tractor stability. Computer aided design and its application in farm tractors.

**Practical** : Engine design calculations, transmission component design calculations. Extensive practices on the computer aided design packages.

**FMPE-505 Design of Farm Machinery I** **2+1** **Sem. I**

**Unit I** Farm machinery design: Modern trends, tasks and requirements, economic considerations of durability, reliability and rigidity. Physico-mechanical properties of soils. Technological process of ploughing. Wedge. Working process of mould board plough, determination of basic parameters. Design of coulters, shares, mould boards.

**Unit II** Constructing of mould board working surface. Design of landside, frog, jointer. Forces acting on plough bottom and their effect on plough balance: Trailed, semi mounted and mounted plough. Draft on ploughs, resistance during ploughing. Design disk ploughs: Concave disk working tools, forces acting.

**Unit III** Machines and implements for surface and inter row tillage; Peg toothed harrow, disk harrows, rotary hoes, graders, rollers, cultivators. Design of V shaped sweeps. Rigidity of working tools. Rotary machines: Trajectory of motion of rotary tiller tynes, forces acting, power requirement. Machines with working tools executing an oscillatory motion.

**Unit IV** Methods of sowing and planting: Machines, agronomic specifications. Sowing inter-tilled crop. Grain hoppers: Seed metering mechanism, furrow openers and seed tubes. Machines for fertilizer application: Discs type broadcasters. Organic fertilizer application: Properties of organic manure, spreading machines. Liquid fertilizer distributors. Planting and transplanting: Paddy transplanters, potato planters.

**Practical** : Design of mould board working surface; Coulter, frog, share, jointer, mould board plough. Trailed, semi mounted and mounted ploughs. Design of disc plough, disc harrow, peg tooth harrow, cultivators, sweeps. Design of rotary tiller. Design of traction and transport devices. Design of seed drills; Metering mechanism, hopper, furrow opener. Fertilizer spreader, liquid fertilizer applicators and design of its sub systems. Design of paddy transplanters and potato planters.

**FMPE-506 Design of Farm Machinery-II** **1+1** **Sem. II**

**Unit I** Pesticide calculation examples. Multidisciplinary nature of pesticide application. Overview of chemical control integrated pest management. Targets for pesticide deposition. Formulation of pesticides.

**Unit II** Spray droplets. Hydraulic nozzles. Power operated hydraulic sprayer design principles. Air assisted hydraulic sprayer design principles. Controlled droplet application. Electrostatically charged sprayers. Spray drift and its mitigation. Aerial spraying systems. Use of drones for spraying: Design of spray generation and application issues.

**Unit III** Introduction to combine harvesters: Construction, equipment subsystems, power sub systems. Crop harvesting: Plant properties, physical and mechanical properties of plant stem, plant bending modeling. Properties of plant grain: Physical, mechanical, grain damage. Properties of MOG; Mechanical and aerodynamic.

**Unit IV** Design of grain header; Orienting and supporting reel. Plant cutting cutter bar: Working process, cutter bar drive. Knife cutting speed pattern area. Design of auger for plant collection. Corn header: Working elements, snapping roll design, stalk grasping and drawing process. Corn ear detachment: Stalk cutting and chopping.

**Unit V** Cereal threshing and separation; Design of tangential and axial threshing units. Performance indices of threshing units. Modeling material kinematics in different threshing units. Factors influencing the threshing process and power requirement. Separation process and design of straw walker. Cleaning Unit process and operation. Grain pan; Chaffer and bottom sieve. Blower design and flow orientation. Design of conveying system for grain. Straw choppers and shredders.

**Practical** : Measurement of spray characters for different nozzles. Problems on sizing of sprayer components. Design of sprayer for special purpose: Orchard and tall trees. Harvesting machine. Problems on design of cutterbars, reels, platform auger, conveyors. Design of threshing drum: Radial and axial flow type. Design of cleaning and grading systems. Design of blowers.

**FMPE-507 Management of Farm Power and Machinery System** **2+1** **Sem. I**

**Unit I** Importance and objectives of farm mechanization in Indian agriculture, its impact, strategies, myths and future needs. Estimation of operating cost of tractors and farm machinery. Management and performance of power, operator, labour. Economic performance of machinery, field capacity, field efficiency and factors affecting field efficiency.

**Unit II** Tractor power performance in terms of PTO, drawbar and fuel consumption. Power requirement problems to PTO, DBHP.

**Unit III** Selection of farm machinery, size selection, timeliness of operation, optimum width and problem related to its power selection. Reliability of agricultural machinery. Replacement of farm machinery and inventory control of spare parts.

**Unit IV** Systems approach to farm machinery management and application of programming techniques to farm machinery selection and scheduling. Network Analysis: Transportation, CPM and PERT, dynamic programming, Markov chain.

**Practical** : Study of latest development of different agricultural equipment and implements in India and other developing countries. Size selection of agricultural machinery. Experimental determination of field capacity of different farm machines. Study of farm mechanization in relation to crop yield. Determination of optimum machinery system for field crop and machine constraints. To develop computer program for the selection of power and machinery.

**FMPE-511 Principles of Automation and Control** **2+1** **Sem. II**

**Unit I** Introduction to industrial automation and control: Architecture of industrial automation systems, review of sensors and measurement systems. Introduction to process control: PID control, controller tuning, implementation of PID controllers, special control structures, feed forward and ratio control, predictive control, control of systems with inverse response, cascade control, overriding control, selective control and split range control.

**Unit II** Introduction to sequence control: PLCs and relay ladder logic, sequence control, scan cycle, RLL syntax, sequence control structured design approach, advanced RLL programming, the hardware environment, Introduction to CNC machines.

**Unit III** Control of machine tools: Analysis of a control loop, introduction to actuators. Flow control valves, hydraulic actuator systems, principles, components and symbols, pumps and motors. Proportional and servo valves. Pneumatic control systems, system components, controllers and integrated control.

**Unit IV** Control systems: Electric drives, introduction, energy saving with adjustable speed drives stepper motors, principles, construction and drives. DC motor drives: Introduction to DC-DC converters, adjustable speed drives. Induction motor drives: Introduction, characteristics, adjustable speed drives. Synchronous motor drive-motor principles, adjustable speed and servo drives.

**Unit V** Networking of sensors, actuators and controllers, the fieldbus, the fieldbus communication protocol, introduction to production control systems.

**Practical** : Control system practical: Characteristics of DC servomotor, AC/DC position control system. ON/OFF temperature control system. Step response of second order system, temperature control system using PID level control system. Automation: Introduction to ladder logic, writing logic and implementation in ladder. PLC programming, water level controller using programmable logic controller. Batch process reactor using programmable logic controller. Speed control of AC servo motor using programmable logic controller.

**FMPE-512 Principles of Hydraulic and Pneumatic Systems** **2+1** **Sem. I**

**Unit I** Hydraulic power, its advantages, applications, properties of hydraulic fluids, viscosity, bulk modulus, density. Concepts of energy of hydraulic systems, laws of fluid flow.

**Unit II** Hydraulic pump and motors, principle, capacity, classifications, working, performance. Design of various types of pumps and motors.

**Unit III** Actuators, types, design of linear actuator and rotary actuators. Hydraulic rams, gear motors, piston motors and their performance characteristics. Hose, filters, reservoirs, types of circuits, intensifier, accumulator, valves. Valve types: Direction control, deceleration, flow, pressure control, check valve and their working etc.

**Unit IV** Hydraulic circuit design. Applications in farm power and machinery: Tractor, combine, farm machinery systems, hydrostatic system etc.

**Unit V** Power pack, pneumatic circuits, properties of air. Compressors, types. Design of pneumatic circuits.

**Practical** : Study of various hydraulic pumps, motors, valves, directional control valves, cylinder piston arrangements, engineering properties of hydraulic fluids, hydraulic system of tractor, power steering system.

**FMPE-513 Applied Instrumentation in Farm Machinery** **2+1** **Sem. I**

**Unit I** Strain gauges, types and applications in two and three dimensional force measurement in farm machinery. Various methods of determining strain/stresses experimentally. Design, selection and analysis of strain gauges.

**Unit II** Introduction to transducers (sensors). Active and passive transducers, analog and digital modes, null and deflection methods. Performance characteristics of instruments including static and dynamic characteristics.

**Unit III** Load cells, torque meters, flow meters types and principles of working. Devices for measurement of temperature, relative humidity, pressure, sound, vibration, displacement (LVDT) etc. Recording devices and their types. Measuring instruments for calorific value of solid, liquid, and gaseous fuels.

**Unit IV** Basic signal conditioning devices, data acquisition system. Micro computers for measurement and data acquisition. Data storage and their application including wireless communication. Application of sensors in farm machinery and power: Tractor and selected farm machinery.

**Practical** : Calibration of load cells, torque meters, flow meters etc. Experiment on LVDT, strain gauge transducer, speed measurement using optical devices, vibration measurement, making of thermocouples etc, application of sensors in farm machinery like wheel hand hoe, etc.

**FMPE-514 Systems Simulation and Computer Aided Problem Solving in Engineering 1+1 Sem. II**

**Unit I** Mathematical modeling and engineering problem solving: Conservation laws and engineering. Computers and software: Software development, structured programming, logical representation. Modular programming. Approximation: Round off errors, truncation errors, significant figures, accuracy and precision.

**Unit II** Nature of simulation: Systems models and simulation, discreet event simulation, time advance mechanisms, components of discrete event simulation model, simulation of single server queuing system. Program organization and logic, development of algorithm. Simulation of an inventory system.

**Unit III** Solving roots of equation using computers. Application in: Ideal and non-ideal gas laws, open channel flows, design of an electric circuit, vibration analysis. Solving linear algebraic equation on computers: Naïve Gauss Elimination, techniques for improving solutions, LU decomposition and matrix inversion. Application in: Steady state analysis of chemical reactors, statically determinate truss, current and voltage in circuits, spring mass systems.

**Unit IV** Optimization techniques. Search techniques: Golden Sections, quadratic interpolation. Application: Optimum design of tank, least cost treatment of wastewater, power transfer for circuits. Solving ordinary differential equation on computers: Modeling engineering systems with ordinary differential equation, solution techniques using computers.

**Practical** : Comparison of analytical and numerical solutions using Spread sheet. Generation of random variables. Generation of discreet and continuous random variate-coding. Implementation of single server queue on computer. Exercises with software packages for roots of equation: Solving linear algebraic equation, curve fitting and optimization. Solving simultaneous equation through Gauss elimination, solving steady state analysis of chemical reactors, statically determinate truss, current and voltage in circuits, spring mass systems on computers. Application of ordinary differential equation to solve mixed reactor problems, predator prey models and chaos.

**FMPE-515 Computer Aided Design of Machinery 0+2 Sem. II**

**Practical** : Learning 2D drafting: Controlling display settings, setting up units, drawing limits and dimension styles. Drawing and dimensioning simple 2D drawings, keyboard shortcuts. Working with blocks, block commands. Exercise in simple assembly in orthographic. Exercise in measuring and drawing simple farm machinery parts. Learning 3D Drafting: Advantages of virtual prototyping-starting the 3D drafting environment, self-learning tools, help and tutorials. Familiarizing with user interface, creating files and file organization, structuring and streamlining. Features of document window. Concept of coordinate system: Working coordinate system, model coordinate system, screen coordinate system, graphics exchange standards and database management system. Working with feature manager and customizing the environment. Planning and capturing design intent. Documentation of design. Using design journal and design binder. Preliminary design review and layout.

Practice in drawing 2D sketches with sketcher and modifying sketch entries. Adding Reference geometry: Planes and axes. Adding relations and working with relations. Dimensioning a sketch. Exercises.

Parts and features: Sketched features and applied features, pattern and mirror features. Documenting design. Assembly: Creating and organizing assemblies, connecting parts and subassemblies with mates. Organizing the assembly by using layouts.

Exercise in creating drawing: Setting up and working with drawing formats, creating drawing views from the 3D model, making changes and modifying dimensions. Case studies: Measuring and drawing assemblies of farm implements and their components.

**FMPE-516 Advanced Manufacturing Technologies** **2+1** **Sem. II**

**Unit I** Material and their characteristics, structure and properties of materials, wood, ferrous, Non-ferrous, alloys, plastic, elastomers, ceramics and composites. Material selection and metallurgy: Equilibrium diagram, time temperature transformation curves, heat treatments, surface treatment: Roughness and finishing.

**Unit II** Measurement and quality assurance: Quality control, tolerance, limits and clearance. Automated 3-D coordinate measurements. Advance casting processes and powder metallurgy. Forming process: Fundamentals of metal forming, hot and cold rolling, forging processes, extrusion and drawing.

**Unit III** Workshop practices applied in prototype production, jigs and fixtures. Traditional machining processes: Cutting tools, turning, boring, drilling, milling and related processes. Non-traditional machining processes fuzzy c-mean (FCM), electric discharge machining (EDM), laser beam machining (LBM), Abrasive jet machining (AJM), and Wire-electro-discharge machining (EDM).

**Unit IV** Joining processes: Gas flame processes, arc processes, brazing and soldering, adhesive and bonding.

**Unit V** Numerical control: Command system codes, programme, cutter position X and Y, incremental movements, linear contouring, Z movements and commands. Manufacturing systems and automation. Robotics and robot arms. 3-D printing. Integrated manufacturing production system.

**Practical** : Identification of material and their application. Study of heat treatment processes and their suitability with respect to materials. Tool and equipment for measurements: Tolerance limits, clearance and surface finish. Site visits for study of advanced manufacturing techniques. Case studies.

**FMPE-517 Machinery for Precision Agriculture** **2+1** **Sem. II**

**Unit I** Importance of precision agriculture. Mapping in farming for decision making. Geographical concepts of Precision Agriculture. Understanding and identifying variability

**Unit II** Geographical Position System (GPS) Basics (Space Segment, Receiver Segment, Control Segment), Error and correction, Function and usage of GPS. Introduction to Geographic Information system (GIS), function of GIS, use of GIS for decisions. IDI devices usage in Precision Agriculture Yield monitor, variable rate applicator for fertilizers, seed, chemicals etc. Remote sensing Aerial and satellite imagery. Above ground (non-contact) sensors.

**Unit III** Data analysis, concepts of data analysis, resolution, Surface analysis. Analysis application interpretive products (map, charts, application map etc).

**Unit IV** Electronics and Control Systems for Variable rate applications, Precision Variable Equipment, Tractor-Implement interface technology, Environmental Implications of Precision Agriculture.

**Unit V** Goals based on end results of Precision Agriculture, Recordkeeping, Spatial Analysis, Variable Rate Application, Reducing of negative environmental impact, Crop/ technology cost optimization. Economic of precision agriculture and determining equipment and software, review of Cost/Benefit of Precision Agriculture, System vs. Parcels. Making a selection.

**Practical** : Calculation of the benefits of Data and Mapping, Determining Latitude/Longitude, UTM or State Plane Position Navigation with Waypoints, Configuring a GPS System. Defining area of field for prescriptive treatment. Making the Grid, The Grid Sampling Process, generation of yield maps, Thematic or Spatial Resolution, Yield Map Example, Surface Analysis in Arc-View.

**FMPE-518 Machinery for Horticulture and Protected Agriculture** **2+0** **Sem. II**

**Unit I** Vegetable cultivation, nursery machinery, tray seeders, grafting machines, vegetable trans-planters. Machinery for planting crops on raised beds, mulch laying and planting machines. Harvesting of vegetable crops: Harvesting platforms and pickers.

**Unit II** Machinery for orchard crops: Pit diggers, inter-cultivators and basin forming equipment for orchards. Machinery for transplanting of trees. Harvesters for fruit crops: Shaker harvesters, types and principle of operation. Elevated platforms for orchard management and harvesting. Pruning machines.

**Unit III** Machinery for orchards, vineyard machinery spraying machines, inter-cultivation machines. High clearance machines and special purpose machinery for crops on trellis. Machinery for special crops: Tea leaf harvesters, pruners and secateurs.

**Unit IV** Machinery for lawn and garden: Grass cutters, special machinery for turf maintenance. Turf aerators and lime applicators.

**Unit V** Protected agriculture: Principles, mechanical systems of greenhouse, ventilation systems, shading system, water fogging system, irrigation system, sensors, electrical and electronic system. Intelligent Control system for greenhouses. Machinery for processing of growth media, tray filling machines-tray sowing machines, transplanting machines. Robotic grafting machines. Weeding and thinning equipment. Crop protection and harvest under protected agriculture.

**FMPE-591 Seminar** **1+0**

**FMPE-599 Masters' Research** **0+30**

## Ph.D. courses

**FMPE-601 Advances in Farm Machinery and Power Engineering** **2+1** **Sem. II**

**Unit I** Advances in mechanization as applicable to Indian context. Future outlook for improving agricultural productivity and reducing cost. Mechanization: Review of the applications of some of the advanced mechanization technologies and constraints in adaptability. Levels of mechanization and transition between levels.

**Unit II** Sustainable mechanization management: Management of compaction of agricultural fields. Strategies to develop machinery and systems that reduce compaction. Concept of Controlled Traffic Farming (CTF) systems. Introduction of wide span mechanization to vegetable production systems to enhance productivity and sustainability.

**Unit III** Optimization of production processes to minimize energy loss in agriculture. The rationale for the use of photovoltaic systems in farming. The Energy Returned on Energy Invested (EROEI) ratio as an indicator for evaluating the efficiency of renewable energy sources.

**Unit IV** Board sensors, computing hardware, algorithms and software. Manipulator type ag-robots: Use in food processing, dairy, horticulture, and orchard industries.

**Unit V** Precision Livestock Farming (PLF): Individual identification and monitoring of animals, tractability of livestock products. Developments in livestock and building control: Radio telemetry systems to remotely monitor and record physiological parameters. Silage process and their variants. Coordination of machinery system to enhance quality of silage and forage conditioners.

**Practical :** Case studies and presentations on: Mechanization in India-analysis of machinery data-mechanization index and relation between productivity and mechanization. Levels of mechanization in different crops. Design of traffic lanes-field geometry and generating guideline lanes for operation of machinery. Planning use of multiple machinery-sugarcane harvesting system. Measurement of soil compaction due to heavy machinery using cone penetrometer. Machine vision system design–case studies. Challenges in development of robotic machinery in agricultural operations-case studies.

**FMPE-602 Advances in Machinery for Precision Agriculture** **2+1** **Sem. I**

**Unit I** Global navigation satellite system (GNNS). Satellite ranging: Accuracy, standards, components of GIS, data layers, map component, attribute table component, function of a GIS, resolution. Data formats: Vector or raster. GIS for precision farming, data analysis, field calculator, convert to grid, interpolation, reclassification, image classification, band math, interpretation of analysis, farm management information systems, and crop intelligence.

**Unit II** Yield Monitors: Components, Differential GPS Receiver, GNSS Receiver, mass flow sensors. Impact plates, measuring volume with a photoelectric sensor. Using microwave radiation, and Gamma rays to estimate volume, volumetric flow sensing and alternatives. Grain moisture sensor, fan speed sensor, elevator speed sensor, header position, yield monitor data, cotton yield monitors.

**Unit III** Sources of soil variability, general soil sampling basics, systematic variability, selecting a soil sampling strategy. Parameters: Electrical conductivity, electromagnetic sensors, sensing mechanical impedance. Proximal plant sensing systems, crops canopy reflectance and fluorescence. Machine vision thermal sensors, mechanical sensors, acoustic sensors.

**Unit IV** Remote sensing platforms: Aircraft or satellite. Sensors: Imaging or non-imaging, active or passive. Making use of reflected energy or emitted energy. The spectral signature of vegetation, vegetation indices, application to agriculture, nutrient management, weed management, disease and insect management, water management.

**Practical** : Simple programming for automating precision farming calculations. Mathematics of longitude and latitude. Spatial statistics, soil sampling and understanding soil testing results for precision farming, calculations. Supporting management zones, understanding soil, water and yield variability in precision farming. Developing prescriptive soil nutrient maps, essential plant nutrients, fertilizer sources, and application rates calculations. Deriving and using an equation to calculate economic optimum fertilizer and seeding rates cost of crop production.

**FMPE-603 Energy Conservation and Management in Production Agriculture 3+0 Sem. I**

**Unit I** Energy requirement of different operations in agricultural production systems viz. crop, livestock and aquaculture.

**Unit II** Energy conservation through proper management and maintenance of farm machinery, planning and management of agricultural production systems for energy conservation and energy returns assessment.

**Unit III** Development of energy model of farm for efficient energy management in a given agricultural production system.

**Unit IV** Design of integrated energy supply system, Assessment of energy conservation technology.

**Unit V** Case studies on application of various techniques of energy conservation and management. Energy use planning and forecasting for a given system.

**FMPE-604 Mechanics of Tillage in Relation to Soil and Crop 2+1 Sem. I**

**Unit I** Soil condition and soil strength determining factors. General aspects of mechanical behavior of soil elements. Soil compaction, conditions for its occurrence. Methods of estimation of soil compaction by experimental stress distribution. Concept of soil distortion, deformation at constant volume. Expansion of soil at breaking.

**Unit II** Occurrence of soil breaking fundamentals. Measures of resistance against breaking. Shear failure and Coulomb's law. Compaction v/s shear failure. Tensile failure of soil, idealized brittle failure, Griffith's Model. Loading rate and repeated loading effects. Draft calculation using mechanism of rigid soil bodies.

**Unit III** Crop requirements: Root structure, Soil conditions and purpose of tillage, looseness of soil and depth of loosening. Structure of seed bed. Soil properties, properties affected by tillage and those not affected by tillage. Soil compaction, formation of clods and dust. Effect of tillage on erosion and water logging. Impact of climate factors on soil. Tillage requirement for various types of soils.

**Unit IV** Tillage operations for special tasks. Preparation of soil for cropping and stubble management. Primary and secondary tillage. Ploughing and its effect on soil. Disc tillage: Appropriate conditions and effect. Requirement of seed bed and techniques of creating proper seed bed. Quality of sowing and sowing methods. Modern trends and objectives of soil tillage.

**Unit V** Plough bodies: Generalized representation, intake main flow and output process. Main flow under different surface curvatures. Kinetic aspects of plough bodies with different shapes. Draft of plough bodies as affected by moisture, speed and attachments.

**Practical** : Characterization of soil condition before and after tillage. Cone penetrometer resistance, bulk density, moisture content. Measurement of forces on tillage tools under soil bin condition/ field condition. Measurement of soil manipulation by different tillage tools: Pulverization, furrow profile, inversion and mixing. Measurement of energy required for soil breakup by different methods. Field study of crop root development in relation to soil compaction and hard pan. Measurement of moisture movement in different surface configuration: Ridges, furrows, raised bed and flat bed. Field evaluation of plant establishment in relation to planting parameters.

**FMPE-611 Mechanics of Traction and its Application 2+1 Sem. II**

**Unit I** Tractor performance in soft soils, operational states of wheel: Wismer and Luth. Path traced by point on tyre periphery. Rolling resistance, conditions of wheel soil interaction, theoretical prediction, work on soil deformation, Bekke's model, derivation of resistance offered by flat rigid plate on soft soil. Measurement of sinkage parameters. Soft wheel on soft surface and rigid wheel on soft surface. Empirical prediction of tractive force: Bekker's model, stress deformation relation in soil, analysis of tractive performance of tracks.

**Unit II** Empirical modeling of tractor performance, tractive performance modeling and mobility number. Empirical models for rolling resistance and traction by Gee-Clough. Derivation of equations for drawbar pull and drawbar power.

**Unit III** Rigid wheel systems. Rigid wheel at rest: Soil bearing capacity, contact pressure and sinkage. Rigid wheel at driving state: Ground reaction on rigid wheel during driving action, force balance in soil reaction to driving wheel, determination of driving force, compaction resistance and effective driving force. Energy equilibrium under driving wheel.

**Unit IV** Wheel under braking state: Slip velocity and amount of slippage under braked wheel. Soil deformation under braked wheel. Distribution of shear stresses and normal stress under driving wheel.

**Unit V** Tyre wheel system-deformation of tyre and area of contact. Deformation of tyre and its measurement. Tyre deformation as function of inflation pressure. Ground reaction during pure rolling of tyre on hard surface. Traffic ability in soft terrain, concept of wheel mobility number-cornering characteristic of wheel forces on a steered wheel under driving and braking conditions. Relation between cornering force and self-aligning torque.

**Practical** : Measurement of soil parameters for modeling traction-simulation of the different traction models to obtain the tractive performance. Calculating the performance of tractor drive wheels, Braking performance of trailer wheels on road, Planter metering drive wheels, Tractor front wheel. Measurement of performance of tyres under soil bin condition/field condition for driving and braking. Measurement of variation in contact patch of tractor tyres under different inflation pressures. Design of lugged wheels for wet puddle soil condition. Field experiment with tractive performance of tractor.

**FMPE-612 Farm Machinery Management and Systems Engineering 2+1 Sem. II**

**Unit I** Mathematical models of field machinery systems: Operational constrains, power constrains, weather constrains. Systems approach to field operations and models of: Tillage, seeding, chemical application, harvesting, storage and irrigation systems.

**Unit II** Engineering economics: Concept of incremental and differential cost, economic efficiency, time value of money. Equipment investment cost: Operational cost, production cost, income cost and uncertainty cost. B.C. ratio, payback period, IRR machinery replacement policies.

**Unit III** Uncertainty: Concepts of probability, probability functions, distributions, sampling. Statistics, confidence limits, significance, contingency tables, analysis of variance. Regression and correlation. Monte Carlo methods and applications to farm machinery.

**Unit IV** System modeling in farm machinery: Numerical methods, analogs, models with uncertainty stochastic service system. Feasibility system design-stability. Deterministic systems and stochastic systems.

**Unit V** Optimum Design: Trial and error, differential calculus, calculus of variations. Allocations: Linear programming, simplex technique. Transportation and assignment technique. Critical path scheduling, dynamic programming, game and its applications to farm machinery management.

**Practical** : Solving problems of mathematical models of field machinery, constraints, power constraints, weather constraints. Problems relates to tillage seeding chemical application harvesting and storage and irrigation systems. Problem solving in Economics of Engineering, calculation of investment cost, operational cost, and uncertainty cost. Case studies in machine performance modeling, Economics of machine selection, Analog components, Analog modeling stochastic system modeling and critical path scheduling.

**FMPE-613 Machinery for Special Farm Operations** **2+0** **Sem. I**

**Unit I** Machinery for land development. Tractor operated and self-propelled machines for laying drainage system, sub surface drip laying machines, subsoiler, trenchers, laser levelers.

**Unit II** Machines for plant protection, pneumatic, thermal type sprayers, aero/drone spraying and other methods of spraying, electrostatic charging, air sleeve boom sprayer, disinfection of seed beds by micro waves and other methods. Safety aids for operator and advances in plant protection method.

**Unit III** Field plot machinery and its importance. Fertilizer and manure spreader.

**Unit IV** Machines for residue management. Silage and hay making machines.

**Unit V** Machinery for horticultural crops. Crop specific machines for cotton, sugarcane, forage/fodder. Machines for processing and handling of agricultural products.

**FMPE-614 Ergonomics in Working Environment** **2+1** **Sem. II**

**Unit I** Musculoskeletal problems in sitting and standing postures-behavioral aspects of posture, body mechanics. Workspace design for standing and seated workers. Display units, controls and human-machine interaction, design of static work.

**Unit II** Noise and noise control. Measurement of noise and safe limits. Protection from noise. Vibration and health. Vibrations generated by agricultural machines. Types of vibrations: Whole body vibrations and hand transmitted vibrations. Methods of measurements of vibrations, hazards of vibrations. Vibration White Fingers (VWF). Vibration reductions in agricultural machines.

**Unit III** Working environment-heat and cold stress conditions. Thermal balance of human body. Measurement of thermal environment. Heat and cold stress condition. Thermoregulatory system of human body. Heat and cold acclimatization. Effect of climate on human performance. Environmental dust and its measurement: Organic and inorganic dust. Types of dust and their hazards: Respirable, thoracic and inhalable dust. Personal protection from dust.

**Unit IV** Time motion study and its purpose. Application of Time motion study in agricultural and processing operations. Recent research works related to ergonomics in agriculture.

**Practical** : Design of workspace for static work in standing and sitting positions. Study of body mechanics and postures in design of agricultural machinery. Human energy expenditure, calibration of subjects, Human work load and its assessment. Study of work and rest schedule. Measurement of visibility of tractors. Measurement and control of noise in tractors and self-propelled machines. Measurement of human vibrations in farm tractors and agricultural machines. Study of dust generated in agricultural operations.

**FMPE-691 Seminar I** **1+0**

**FMPE-692 Seminar II** **1+0**

**FMPE-699 Ph.D Research** **0+75**

# PROCESSING AND FOOD ENGINEERING

## PROGRAMMES

**M. Tech.**

**Ph. D.**

## COURSE REQUIREMENTS

### M. Tech.

| | |
|---|---|
| Field of Specialization | Processing & Food Engineering |
| Required Courses | PFE-501, PFE-502, PFE-503 and PFE-504 |
| Supporting Courses | Stat.-502, Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem. |
| Minor Field | Mechanical Engineering, Renewable Energy Engineering, Farm Machinery & Power Engineering, Computer Science and Engineering, Mathematics, Statistics and Physics, Civil Engineering or any other as approved by the Dean, Postgraduate Studies. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's advisory committee and approved by the Dean, Postgraduates Studies |

### Ph. D.

| | |
|---|---|
| Field of Specialization | Processing & Food Engineering |
| Required Courses | PFE-601and PFE-602 |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Minor Field | Computer Science and Engineering, Renewable Energy Engineering, Mechanical Engineering, Civil Engineering or any other as approved by the Dean, Postgraduate Studies. |
| Deficiency Courses | As recommended by student's advisory committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**PFE 51 Elementary Agro-Processing** **1+1** **Sem. I**

**(For Students of College of Agriculture)**

Concept of agro processing and its importance in context to Punjab. Concept of Agro Processing complexes. Layout and Planning. Components of Agro Processing Complex. Unit operations in agro-processing industry. Milling of wheat and its machinery. Milling of paddy and its machinery. Milling of pulses and its machinery. Oil seed processing and machinery.

**Practical:** Milling quality of paddy, knowledge about rice, wheat, oilseed and pulses milling machinery. Visit to agro processing complexes.

**PFE 102 Post Harvest Engineering** **2+1** **Sem. II**

**(For Students of College of Agriculture)**

Overview of post harvest technology: Concept and science, production and post harvest losses, reasons for losses, importance of loss reduction; Water activity, water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture; Post Harvest Handling operations; Cleaning: Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Sorting and grading: Sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance; Separation: Magnetic separator, destoners, electrostatic separators, pneumatic separator; Decorticating and shelling: Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.; Grain drying theory, grain dryers; Liquid dryers; Parboiling: process, changes during parboiling, parboiling methods, advantages and disadvantages of parboiling with respect to milling, nutritional and cooking quality of grain, significance of glass transition temperature; Milling: milling, polishing, grinding, milling equipments, dehuskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement; Materials handling: Introduction to different conveying equipments used for handling of grains, fruits and vegetables; Scope and importance of material handling devices; Study of different material handling systems: Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types; Pneumatic conveying system: Capacity and power requirement, types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

**Practical:** Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer; Study of vacuum dryer; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

**PFE 201 Unit Operations in Food Processing-I** **2+1** **Sem. I**

**(For Students of College of Agriculture)**

Size reduction- benefits, classification and determination of the fineness of ground material, sieve analysis, principle and mechanisms of comminution, energy laws, size reduction equipments – various types of crushers, grinders, ultrafine grinders and cutting machines, their principle and working. Mixing – theory of solids mixing, mixing indices, rate of mixing, theory of liquid mixing, power requirement, mixing equipments – mixers for liquids and pastes, dry powders and particulate solids. Mechanical separation-theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machines. Filtration – rate of filtration, pressure drop during filtration, constant rate filtration and constant-pressure filtration, filtration equipments, plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids. Membrane separation – general considerations, materials for membrane construction, membrane separation methods, ultrafiltration, processing variables, membrane fouling, application of ultra-filtration in food processing, reverse osmosis, mode of operation and applications, demineralization by electro-dialysis, gel filtration, ion exchange, pervaporation and micro filtration.

**Practical:** Fineness modulus, uniformity index and power requirement in size reduction using Rittinger's, kick' and Bond's law. Performance evaluation of hammer mill and attrition mill. Mixing index of feed mixer. Centrifugal separator. Osmosis in fruits, solid gain and moisture loss during osmosis, reverse osmosis process, ultra-filtration separation process.

**PFE 202 Unit Operations in Food Processing-II** **2+1** **Sem. II**

**(For Students of College of Agriculture)**

Evaporation: principles, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation and Dühring plot), heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient and influence of feed liquor properties on evaporation. Evaporation equipment: natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube and forced circulation. Evaporator ancillary plant, design of evaporation systems, single and multiple effect evaporators, feeding methods, preheating, vapour recompression systems. Recompression heat and mass recovery and vacuum creating devices. Fouling of evaporators and heat exchangers. Food freezing: introduction, freezing point curve for food and water, freezing points of common food materials, freezing principle, time calculation by using Plank's equation. Freezing systems: direct contact systems, air blast immersion, IQF, changes in foods, frozen food properties, factors influencing freezing time and thawing time. Freeze concentration: principles, process and methods. Frozen food storage and quality changes. Freeze drying: heat and mass transfer, equipment and practices. Expression/ Extraction: liquid-liquid extraction processes, equipment and design for liquid-liquid and continuous multistage counter current extraction. Leaching: process, preparation of solids, rate of leaching, equipments, equilibrium relations. Crystallization and dissolution: theory and principles, kinetics, applications, equipments. Distillation: principles, vapour-liquid equilibrium, continuous flow, batch/differential, fractional, steam distillation, distillation of wines and spirits. Baking: principles, baked foods, equipment. Roasting: principles and equipments. Frying: theory, principles, shallow or contact and deep fat frying, heat and mass transfer in frying and equipments. Puffing: methods and equipments. Pasteurization: purpose, microorganisms and their reaction to temperature and other influences, methods of heating, design and operation of vat, tubular and plate heat exchangers. Sterilization: principles, process time, T-evaluation, batch and continuous sterilization, equipments, ultra high temperature (UHT), in the package sterilization and equipment, temperature, pressure patterns and equipment. Aseptic processing: principles, analysis of thermal resilience, conduction heating time calculation. Blanching: principle and equipment. Homogenization and emulsification.

**Practical:** Study of working principle, open pan, vacuum evaporator, single effect evaporator and estimation of heat/mass balance during concentration. Multiple effect evaporator and estimation of heat/mass balance during concentration. Sterilizer, design problems on freezers, numerical problem on thermo bacteriology (D, Z and F values).Freezing of foods by different methods, determination of freezing time of food material and design problems on freezers. Effect of particle size and time on solvent extraction process, temperature on crystallization rate of sugar. Study of blancher, pasteurizers, fryers,

homogenizers and irradiators. Oil uptake by the food products during frying and qualitative changes in the fried food products. Visit to a sugar processing industry.

**PFE 203 Food Refrigeration and Cold Chain** **2+1** **Sem. II**

**(For Students of College of Agriculture)**

Principles and importance, unit of refrigerating capacity, coefficient of performance, production of low temperatures, expansion of a liquid with flashing, reversible/irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling and adiabatic demagnetization. Air refrigerators: Carnot and reversed Carnot cycle, selection of operating temperatures, Bell Coleman and reversed Brayton cycle, analysis of gas cycle, polytropic and multistage compression. Vapour Compression refrigeration system: vapour as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle. Modifications in reverse Carnot cycle with vapour as a refrigerant (dry vs wet compression and throttling vs isentropic expansion), representation of vapour compression cycle on pressure enthalpy diagram, super heating, sub cooling, liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid sub cooling and actual vapour compression cycle. Azeotropes, Components of vapour compression refrigeration system, (evaporator, and compressor, condenser and expansion valve). Vapour absorption refrigeration system: process, calculations and maximum coefficient of performance. Common refrigerants: classification, nomenclature and desirable properties (physical, chemical, safety, thermodynamic and economical). Ice manufacture: principles and systems of ice production, treatment of water for making ice, brines, freezing tanks, ice cans, air agitation and quality of ice. Cold storage: design for different categories of food resources, size and shape, construction, material, insulation, vapour barriers, floors, frost heave, interior finish and fitting, evaporators, automated cold stores and security of operations. Refrigerated transport: handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans and refrigerated display. Air-conditioning: factors affecting, classification, sensible heat factor air-conditioning, industrial air-conditioning, numerical problems on sensible heat factor (winter/summer/year round air-conditioning), unitary, central air-conditioning, physiological principles, air distribution and duct design methods, design of complete air-conditioning systems, humidifiers and dehumidifiers. Cooling load calculations: load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration and peak load.

**Practical:** Study of vapour compression refrigeration system. Determination of COP of vapour compression refrigeration system. Study of types of compressors, condensers, expansion valves, evaporative coils used in refrigeration systems. Study of refrigerants, their properties and charts. Study of direct and indirect contact freezing equipment, spray freezing process and cold storage for foods. Estimation of refrigeration load for cold storage of meat, poultry products, chocolate enrobing process and ice-cream. Study of refrigeration system for dairy plant, bakery and estimation of their refrigeration load. Study of refrigerated van, deep freezing and thawing of foods. Study of refrigerated display of foods and estimation of cooling load.

**PFE 204 Engineering Properties of Agricultural Produce** **1+1** **Sem. II**

Importance of engineering properties of agricultural produce and its classification. Physical properties: shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables. Thermal properties: heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration and co-efficient of thermal expansion. Frictional Properties: static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials. Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties (Force, deformation, stress, strain, elastic, plastic and viscous behaviour). Newtonian and Non-Newtonian liquid, visco-elasticity, pseudoplastic, dilatant, thyrotrophic, rheopectic, bingham plastic foods and flow curves. Electrical properties, dielectric loss factor, loss tangent, A.C. conductivity, dielectric constant and method of determination. Application of engineering properties in handling processing machines and storage structures.

**Practical:** Determination of shape, size, bulk density, angle of repose, true density, porosity, coefficient of external and internal friction, terminal velocity and separating behaviour in a vertical wind tunnel,

thermal conductivity and specific heat of grains, fruits and vegetables. Determination of hardness of food materials and viscosity of liquid foods.

**PFE 301 Food Process Equipment Design 2+1 Sem. I**

**(For Students of College of Agriculture)**

Materials and properties: materials for fabrication, mechanical properties (ductility and hardness), corrosion, protective coatings, corrosion prevention linings, equipment, choice of materials and material codes. Design considerations: stresses created due to static and dynamic loads, combined stresses, design stresses, theories of failure, safety factor, temperature and radiation effects, effects of fabrication method and economic considerations. Design of pressure and storage vessels: operating condition, design conditions and stress, design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. Design of heat exchangers: design of shell and tube, plate, scraped surface heat exchanger, sterilizer and retort. Design of evaporators and crystallizers: single and multiple effect evaporators, components, design of rising and falling film evaporators, feeding arrangements, crystalliser and entrainment separator. Design of agitators and separators: agitators, baffles, agitation system components and drive, centrifuge separator, equipment components, shafts, pulleys, bearings, belts, springs, drives and speed reduction systems. Design of freezing equipment: ice-cream freezers and refrigerated display system. Design of dryers: tray, tunnel, fluidized, spray, vacuum, freeze and microwave dryer. Design of conveyors and elevators: belt, chain, screw, pneumatic conveyor and bucket elevator. Design of extruders: cold and hot, screw and barrel and twin screw extruder. Design of fermenter vessel and numerical problems. Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

**Practical:** Design of pressure vessel, shell and tube heat exchangers, plate heat exchanger, sterilizers and retort, single and multiple effect evaporators, rising and falling film evaporators, crystallizer, fluidized bed, spray, vacuum and microwave dryer. Design of belt, chain, screw, pneumatic conveyor and bucket elevator. Design of twin screw extruder and fermenter.

**PFE 302 Food Storage Engineering 2+1 Sem. I**

**(For Students of College of Agriculture)**

Storage: importance of scientific storage systems, post harvest physiology of semi-perishables and perishables. Climacteric and non climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis. Direct and indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration and sprouting), destructive agents (rodents, birds and insects), sources of infestation and control. Traditional, improved, modern storage structures and farm silos (horizontal, tower, pit and trench silos), size and capacity of silos. Storage of grains: respiration, moisture and temperature changes in stored grains. Conditioning of environment inside storage through ventilation. Aeration and stored grain management: purposes, theory, system design and system operation for aeration. Storage pests and control: damage due to insects, pests and its control, seed coating and fumigation. Storage of perishables: cold, controlled, modified atmospheric, hypobaric and evaporative storage, conditions for storage, control of temperature and relative humidity. Design of storage structures: functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure, capacities, warehouse, silos and BIS specifications. Functional, structural and thermal design of cold stores.

**Practical:** Visits to traditional storage structures, FCI Godowns, cold, CA and evaporative cooled storages. Design, sizing, capacity and drawing of traditional storage structures, FC Godowns, cold, CA and evaporative cooled storages. Measurement of respiration of fruits/grains. Study on fumigation. Drawing and layout of traditional storage structures, FCI grain Godowns, cold, CA and evaporative cooled storages. Storage study in the MAP.

**PFE 303 Protected Cultivation and Secondary Agriculture 1+1 Sem. II**

**(For the College of Agriculture in collaboration with Department of Soil and Water Engineering)**

Engineering properties: physical, thermal, aero and hydrodynamic properties of cereals, pulses and oilseeds. Application of engineering properties in postharvest technology (PHT) equipment design and

operation. Drying and dehydration: moisture measurement, equilibrium moisture content (EMC), drying theory, drying methods, commercial grain dryers (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer an solar dryer). Material handling equipment: conveyers, elevators, principle, working and selection. Green house technology: introduction, types of green houses, plant response to environment, planning and design of green house structures, design criteria for cooling and heating, equipments, materials of construction, irrigation systems and typical applications. Passive solar green house heating/ cooling systems, green house drying. Cost estimation and economic analysis.

**Practical:** Study of different type of green houses based on shape. Determine the rate of air exchange in an active summer/winter cooling/heating system. Drying rate of agricultural products inside green house. Study of green house equipments. Visit to various post harvest laboratories. Engineering properties (shape, size, bulk density and porosity) of bio-materials. Determination of moisture content of various grains by oven , infrared and other moisture meters. Field visit to seed processing plant.

**PFE 304 Agricultural Structures and Environmental Control 2+1 Sem. I**

Planning and layout of farmstead. Scope and importance and need for environmental control of agricultural structures. Physiological reaction of livestock environmental factors, environmental control system and their design, control of temperature, humidity and other air constituents by ventilation and other methods. Livestock production facilities. BIS standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, fencing and implement shed, barn for cows, buffalo, poultry etc. storage of grains, causes of spoilage, water activity for high and low moisture food and its limit for storage, moisture and temperature changes in grain bins. Traditional and improved storage structures (CAP, hermetic storage, PUSA bin and RCC ring bins), design consideration for grain storage godowns, bag storage structures, shallow and deep bin, calculation of pressure in bins. Storage of seeds. Rural living and development, rural roads, their construction cost, repair and maintenance. Sources and norms of water supply, drinking water standards and water treatment, suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation systems, sewage systems and its design, cost and maintenance, design of septic tank for small family. Estimation of domestic power requirement, source of power supply and electrification of rural housing.

**Practical:** Measurement for environmental parameters and cooling load of a farm building. Design and layout of a dairy farm, poultry house, goat house and sheep house. Design of a farm fencing system, feed and fodder storage structure, grain storage structures, commercial bag and bulk storage facilities. Performance evaluation of different domestic storage structure. Cost estimation of farm buildings.

**PFE 305 Post Harvest Engineering of Cereals, Pulses and Oil Seeds 2+1 Sem. I**

Cleaning and grading of grains, aspiration, scalping, size separators, screens and sieve analysis, capacity and effectiveness of screens. Separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), and size reduction machinery (Jaw crusher, hammer mill, plate mill and ball mill). Conveyors: belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated) and pneumatic conveying. Drying: moisture content, water activity, free, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, equilibrium moisture content (EMC) determination. Psychometric chart and its use, drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, mass, energy balance, Shedd's equation and dryer performance. Methods of drying, tempering during drying. Grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes. Milling of rice: conditioning and parboiling, traditional methods, CFTRI, Jadavpur and pressure parboiling methods, types of rice mills, modern rice milling, different unit operations and equipment. Milling of wheat: unit operations and equipments. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry and wet milling: CFTRI and Pantnagar methods, pulse milling machines. Milling of corn and its products, dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of

oilseeds, stabilization of rice bran and refining of oil. Extrusion cooking: principle, factors affecting single and twin screw extruders. By-products utilization.

**Practical:** Performance evaluation of different types of cleaners and separators. Size reduction machines, performance evaluation, fineness modulus and uniformity index. Types of conveying and elevating equipments. Mixers and types of mixers. Moisture content: dry and wet basis, drying characteristics, drying constant and EMC (Static and dynamic method). Various types of dryers. Performance evaluation of different equipments in rice, pulse and oil mills. Process flow charts with examples relating to processing of cereals, pulses and oil seeds. Visit to grain processing industries.

**PFE 306 Post Harvest Engineering of Horticultural Crops 2+1 Sem. II**

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing. Peeling: methods and devices (manual, mechanical, chemical, and thermal peeling). Slicing of horticultural crops: equipments for slicing, shredding and chopping. Crushing and juice extraction. Blanching: importance and objectives, blanching methods, effects on food (nutrition, colour, pigment, and texture). Chilling and freezing: requirements, thermophilic, mesophilic and psychrophilic microorganisms of fruits and vegetables, effects on food during chilling and freezing, application of refrigeration in different perishable food products, freezing time calculations, slow and fast freezing, equipments (mechanical and cryogenic). Cold storage heat load calculations and design. Refrigerated vehicle and cold chain system Dryers for fruits and vegetables. Osmo-dehydration. Packaging: requirements in terms of light transmittance, heat, moisture and gas proof, micro organisms and mechanical strength, packaging materials, products, bulk and retail packages and packaging machines. Handling and transportation of fruits and vegetables. Pack house technology. Minimal processing. Methods of storage: low temperature, evaporative cooled, controlled atmosphere, modified atmosphere packaging. Preservation technology: methods of preservation of fruits and vegetables, brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation. Flowcharts for preparation of different finished products, important parameters and equipment used for different unit operations. Post harvest management and equipments for spices and flowers. Quality control in fruit and vegetable processing industry. Food supply chain.

**Practical:** Performance evaluation of peeler, slicer, juicer, pulper, blanching equipment, testing adequacy of blanching, cold storage design, controlled atmosphere (CAP) and modified atmosphere packaging (MAP) storage. Minimal processing of vegetables. Preparation of value added products, Visit to fruit and vegetable processing industry and spice processing plant.

**PFE 307 Dairy and Food Engineering 2+1 Sem. II**

Deterioration in food products and their controls. Physical, chemical and biological methods of food preservation. Nanotechnology: concepts, tools, techniques, applications in food packaging and products, implications, environmental impact of nano-materials and their potential effects on global economics and regulation of nanotechnology. Dairy development in India. Engineering, thermal and chemical properties of milk and milk products, process flow charts for dairy products. Unit operations of dairy and food processing systems. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization and centrifugation for cream separation. Methods and equipment for manufacture of cheese/ paneer, butter and ice cream. Packaging of milk and milk products. Dairy plant design and layout, plant utilities, principles of operation and equipment for thermal processing, canning and aseptic processing. Evaporation: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression. Drying of liquid and perishable foods principle, spray, drum and freeze drying. Filtration: principle, types of filters, membrane separation, reverse osmosis (RO), nano, ultra and macro-filtration, equipment and applications. Non-thermal and alternate thermal processing in food.

**Practical:** Study of pasteurizers, sterilizers, homogenizers, separators, butter churns, evaporators, milk dryers, freezers and filtrates. Design and layout of food processing plants, visit to multi-product dairy plant. Estimation of steam and refrigeration requirements in dairy and food plant. Visits to food industry and dairy plant.

## Elective courses

**PFE 401 Development of Processed Products** **2+1** **Sem. II**

Composition of food and their waste and by-products. Process flow chart with mass and energy balance, unit operations and equipments for processing. Uses of food waste, waste disposal. New product development. Technology for value added products from cereal, pulses and oil seeds. Milling, puffing, flaking, roasting, bakery, snack foods and extruded products. Oil extraction and refining. Technology for value added products from fruits, vegetables, spices, canned foods, frozen foods, dried and fried foods, fruit juices and sauce. Sugar base confection, candy, fermented food product and spice extracts. Technology for animal produce processing: meat, poultry, fish and egg products. Health foods: nutra-ceuticals, functional and organic food.

**Practical:** Process design and process flow chart preparation, mass and energy balance in food processing. Preparation of value added products. Visit to study operation and machinery of roller wheat flour, rice, spice grinding, sugar, dal and oil mill, fruit/vegetable, meat, poultry and fish processing and milk plants. Process flow diagram and study of various models of the machines used in sugar mill.

**PFE 402 Food Quality and Control** **2+1** **Sem. II**

Basics of food science and food analysis, concept, objectives and need of food quality. Measurement of colour, flavor, consistency, viscosity, texture and their relationship with food quality and composition. Sampling: purpose, techniques, procedures for liquid, powdered and granular materials. Quality control: tools, statistical quality control, sensory evaluation methods, panel selection methods, interpretation of sensory results, methods and instrumental method for testing quality. Food adulteration and food safety. Total quality managements (TQM), Total quality control (TQC), consumer preferences and acceptance. Food safety management systems: Good agricultural practices (GAP), Good hygiene practices (GHP), Good manufacturing practices (GMP), Hazards and HACCP (Hazard analysis and critical control point), Sanitation standards operating procedures (SSOP), Food Laws and Regulations in India, Food safety standards authority of India (FSSAI), Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. Codex Alimentarious Commission (CAC), traceability and quality assurance system in a process plant, bio safety and bioterrorism.

**Practical:** Examination of cereals and pulses from go-downs and market shops in relation to FPO and BIS specifications. Milling quality of food grains. Detection of adulteration and examination of milk, milk products, ghee, jams, jellies, marmalades, spices and honey for various standards of AGMARK, FPO and BIS. Measurement of quality of fresh fruits, vegetables and spices. Visit to quality control laboratory and case study of statistical process control in food processing industry. Registration process, licensing procedure and sampling techniques under FSSAI. Visit to food processing laboratory and study of records and reports.

**PFE 403 Process Equipment Design** **2+1** **Sem. II**

Introduction to process equipment design, application of engineering design for processing equipments, design parameters and general design procedure, material specification, types of material for process equipments and design codes. Design of process equipment: pressure vessel, cleaners, tubular, shell and tube and plate heat exchangers, belt, screw conveyer, bucket elevator, dryers and milling equipments. Optimization of design with respect to process efficiency, energy and cost. Computer Aided Design (CAD).

**Practical:** Design of pressure vessel, cleaners, milling equipments, tubular, shell and tube type, plate heat exchangers, dryer, belt, screw conveyor and bucket elevator.

**PFE 404 Food Plant Design and Management** **2+1** **Sem. II**

Planning of food processing plant, feasibility study (Technical, financial and marketing). Food plant location, selection criteria, selection of processes and plant capacity. Requirements of plant building and its components. Project design, flow diagrams, selection of equipment, process and controls. Objectives and principles of food plant layout. Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish, meat , milk and milk products. Introduction to finance, engineering economics, food product marketing, food business analysis and strategic planning.

Introduction to marketing, Food marketing management, supply chain management for retail food products. Entrepreneurship development in food industry: SWOT analysis, generation, incubation and commercialization of ideas and innovations, new product development process, Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector, procedure of obtaining license and registration under FSSAI, cost analysis and preparation of feasibility report.

**Practical:** Preparation of project and feasibility report. Salient features and layout of pre processing house, milk and milk product plants. Salient features, design and layout of modern rice mill, bakery and related product plant. Types of records relating to production, finance and marketing. Brain storming and SWOT analysis to start a food processing business.

**PFE 405 Food Packaging Technology** **2+1** **Sem. II**

Factors affecting shelf life of foods during storage, interactions of spoilage agents with environmental factors (water, oxygen, light and pH), general principles of control of the spoilage agents, difference between food infection, food intoxication and allergy. Packaging of foods: importance, scope, requirement, packaging strategy, environmental considerations. Packaging systems: type (flexible, rigid, retail and bulk), levels, machines, technical and data management packaging systems. Packaging materials: properties, applications, manufacture of metal cans, plastic packaging, polymers used in food packaging and their barrier properties Manufacture of plastic packaging materials (profile, blown film/ sheet extrusion, extrusion blow molding, injection blow molding, stretch blow molding and injection molding). Glass containers: types, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging: manufacture process, barrier properties, characteristics, advantages, disadvantages and effect of these packaging materials on packed commodities. Nutritional labelling on packages. Controlled atmosphere (CA), modified atmosphere (MA), shrink, cling, vacuum, gas, active and smart packaging. Packaging requirement for raw and processed foods and their selection of packaging materials. Factors affecting the choice of packaging materials, disposal and recycle of packaging waste. Printing, labeling and lamination. Package testing: testing methods for flexible, rigid and semi rigid materials. Tests for packaging materials: paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond and surface oil absorption), plastic film and laminates (thickness, tensile strength, gloss, haze and burning test to identify polymer), aluminium foil (thickness and pin holes), glass containers (visual defects, colour, dimensions and impact strength) and metal containers (pressure test and product compatibility).

**Practical:** Identification of different types of packaging materials. Determination of tensile/compressive strength of given material/package. Destructive and non-destructive test for glass containers. Vacuum packaging of agricultural produce. Determination of tearing strength of paper board. Measurements of thickness of packaging materials. Determination of bursting strength and water-vapour transmission rate of packages. Shrink wrapping of horticultural produce. Testing of chemical and grease resistance of packaging materials. Drop test for food package strength. Visit to relevant industries.

**PFE 406 Waste and By-Product Utilization** **2+1** **Sem. II**

Waste and byproducts generation and utilization in different food processing industries; concept scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in wastewaters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, briquetting of biomass as fuel, generation of electricity, producer gas; waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced wastewater treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal.

**Practical:** Waste characterization; Determination of ash content and carbon in ash of agricultural waste; Briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; waste treatment plant in food industry; utilization of whey; recovery of

peel, germ and germ oil from by-product of cereals; Bioconversion and recycling of agro-wastes and by-products; Visits to various industries using waste and food by-products.

## Postgraduate Courses

**PFE-501 Transport Phenomena in Food Processing 2+1 Sem. I**

**Unit I** Introduction to heat and mass transfer and their analogy. Steady and unsteady state heat transfer. Analytical and numerical solutions of unsteady state heat conduction equations. Use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems: Applications in food processing including freezing and thawing of foods.

**Unit II** Convective heat transfer in food processing systems involving laminar and turbulent flow. Heat transfer in boiling liquids. Heat transfer between fluids and solid foods. Functional design of heat exchangers: shell and tube, plate and scraped surface heat exchangers. Radiation heat transfer: governing laws, shape factors, applications in food processing.

**Unit III** Momentum transfer. Mass flow and balance. Steady and unsteady flow. Theory and equation of continuity. Bernoulli's theorem and application. Flow through immerged bodies, Measurement of flow, pressure and other parameters. Flow driving mechanism.

**Unit IV** Molecular diffusion in gases, liquids and solids. Molecular diffusion in biological solutions and suspensions. Molecular diffusion in solids. Unsteady state mass transfer and mass transfer coefficients. Molecular diffusion with convection and chemical reaction. Diffusion of gases in porous solids and capillaries. Mass transfer applications in food processing.

**Practical** : Solving problems on steady and unsteady state conduction with or without heat generation. Numerical analysis. Problems in natural and forced convection, radiation. Design of heat exchangers. Experiments on heat conduction, convection and radiation heat transfer.

**PFE-502 Unit Operations in Food Process Engineering 2+1 Sem. I**

**Unit I** Review of basic engineering mathematics. Units and dimensions. Mass and energy balance. Principles of fluid flow. Heat transfer: Conduction, convection and radiation. Heat exchangers and their designs.

**Unit II** Drying and dehydration: Psychrometry, theories of drying, EMC, equipment for drying of solid, pastes and liquid foods. Evaporation: Components, heat and mass balance in single and multiple effect evaporators, equipment and applications, steam economy. Thermal processing: Blanching, pasteurization and sterilization, death rate kinetics, process time calculations, sterilization equipment.

**Unit III** Refrigeration and freezing: Principles, freezing curve, freezing time calculation, freezing equipment, cold chain.

**Unit IV** Mechanical separation: Principle and equipment involved in sieving, filtration, sedimentation and centrifugation, cyclone separation. Material handling: Conveyors and elevators, components and design considerations for belt, chain, bucket and screw conveyors.

**Unit V** Size reduction: Principles of size reduction, size reduction laws. Size reduction equipment: Jaw crusher, gyratory crusher, roller mill, hammer mill.

**Practical** : Study of fluid flow properties. Study of heat exchangers, functional design of heat exchangers. Application of psychometric chart. Determination of EMC. Study of driers. Solving problems on single and multiple effect evaporators. Elevating and conveying equipment. Size reduction equipment. Cleaning and sorting equipment. Sieve analysis. Kinetics of fruits and vegetables dehydration. Calculation of refrigeration load, solving of numerical problems. Visit to related food industry.

**PFE-503 Field Crops Process Engineering 2+1 Sem. I**

**Unit I** Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions. Grain quality standards and physico-chemical methods for evaluation of quality of flours.

**Unit II** Pre-milling treatments and their effects on milling quality. Parboiling and drying, conventional, modern and integrated rice milling operations. Wheat roller flour milling. Processes for milling of corn, oats, barley, gram, pulses, paddy and flour milling equipment. Layout of milling plants.

**Unit III** Dal mills, handling and storage of by-products and their utilization. Storage of milled products. Expeller and solvent extraction processing. Assessment of processed product quality.

**Unit IV** Packaging of processed products. Design characteristics of milling equipment, selection, installation and their performance. Quality standards for various processed products. Value added products of cereals, pulses and oilseeds.

**Practical** : Physical properties of cereals and pulses, raw and milled products quality evaluations: Parboiling and drying, terminal velocities of grains and their fractions, study of paddy, wheat, pulses and oilseeds milling equipment, planning and layout of various milling plants. Development of value-added products for cereals, pulses and oilseeds, visit to related agro processing industry.

**PFE-504 Horticultural Crops Process Engineering 2+1 Sem. I**

**Unit I** Importance of postharvest technology of fruits and vegetables, structure, cellular components, composition and nutritive value of fruits and vegetables, fruit ripening, spoilage of fruits and vegetables.

**Unit II** Harvesting and washing, pre-cooling, blanching, preservation of fruits and vegetables, commercial canning of fruits and vegetables, minimal processing of fruits and vegetables.

**Unit III** Cold storage of fruits and vegetables, controlled atmosphere and modified atmosphere packaging of fruits and vegetables, quality deterioration and storage.

**Unit IV** Dehydration of fruits and vegetables, methods, osmotic dehydration, foam mat drying, freeze drying, microwave heating, applications, radiation preservation of fruits and vegetables, irradiation sources.

**Unit V** Intermediate moisture foods, ohmic heating principle, high pressure processing of fruits and vegetables, applications, sensory evaluation of fruit and vegetable products, packaging technology for fruits and vegetables, general principles of quality standards and control, FPO, quality attributes.

**Practical** : Determination of size, shape, density, area-volume-mass relationship of fruits and vegetables, sugar-acid ratio of fruits, evaluation of washer, grader and packaging methods, experiments on drying of fruits and vegetables, controlled atmosphere storage and quality evaluation.

**PFE-505 Storage Engineering and Handling of Agricultural Produce 2+1 Sem. II**

**Unit I** Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements.

**Unit II** Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and thermal design of structures, aeration system.

**Unit III** Grain markets, cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation, BIS standards.

**Unit IV** Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators,principles of fluidization, recent advances in handling of food materials.

**Practical** : Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts, design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators; principles of fluidization; recent advances in handling of food materials.

**PFE-506 Food Package Engineering 1+1 Sem. II**

**Unit I** Introduction of packaging: Package, functions and design. Principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods of prevention.

**Unit II** Food containers: Rigid containers, glass, wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks, corrosion of containers (tin plate). Flexible packaging materials and their properties. Aluminum as packaging material. Evaluation of packaging material and package performance.

**Unit III** Packaging equipment: Food packages, bags, types of pouches, wrappers, carton and other traditional package. Retortable pouches: Shelf life of packaged foodstuff.

**Unit IV** Methods to extend shelf life. Packaging of perishables and processed foods. Special problems in packaging of food stuff.

**Unit V** Package standards and regulation: Shrink packaging, aseptic packaging, CA and MAP. Biodegradable packaging: Recent advances in packaging, active packaging, smart packaging, antioxidant and antimicrobial packaging, edible films and biodegradable packaging, microencapsulation and nano encapsulation.

**Practical** : Thickness, substance weight, water absorption capability of flexible packaging materials, strength properties of packaging materials, water vapour and gas transmission rate of flexible packaging materials, identification and chemical resistance of plastic films. Packaging of fruits/vegetables: Estimation of shelf-life of packaged food stuff, familiarization of types of packaging material.

**PFE-507 Instrumentation and Sensors in Food Processing 2+1 Sem. II**

**Unit I** Basic instrumentation systems and transducer principles. Displacement transducers, Potential meters, LDVT, Piezoelectric and capacitive transducers, Digital transducers, velocity transducers.

**Unit II** Acceleration and absolute motion measurement, Force transducer, Strain gauge, Hydraulic load cell, Cantilever type and probing ring. Method of separation of force: Torque, power and energy measuring technique.

**Unit III** Temperature measurement using bi-metals, thermistor, thermocouples, humidity measurement, manometers. Flow transducer, positive displacement, venturi meter, Rotameter, Drag force, hot wire anemometer.

**Unit IV** Theory and classifications of chemical sensors, biosensors, fiber optic sensors, gas sensors etc. Biosensor: Concepts, types of biosensors, methods of immobilizing biosensors, application. Imaging methods: X-ray imaging, Computed tomography, MRI, Ultrasound, Hyper-spectral imaging. Spectroscopy and chemometrics: UV and visual spectroscopy, NIR spectroscopy, FTIR spectroscopy.

**Practical** : Identification of components of generalized measuring system: Calibration of instruments, experiment on LVDT, strain gauge transducer, force, torque, power and pressure, fluid flow rates, temperature, calorific value, vibration measurement. Use of data loggers and data storage devices, spectroscopy, imaging systems.

**PFE-508 Application of Engineering Properties in Food Processing 2+1 Sem. II**

**Unit I** Physical characteristics of different food grains, fruits and vegetables: Shape and size, description of shape and size, volume and density, porosity, surface area. Rheology: ASTM standard, terms, physical states of materials, classical ideal material, rheological models and equations, viscoelasticity, creep-stress relaxation, non-Newtonian fluid and viscometry, rheological properties, force, deformation, stress, strain, elastic, plastic behaviour.

**Unit II** Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity.

**Unit III** Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Electrical properties: Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high frequency electric field.

**Unit IV** Application of engineering properties in design and operation of agricultural equipment and structures.

**Practical** : Experiments for the determination of physical properties like length, breadth, thickness, surface area, bulk density, porosity, true density, coefficient of friction, angle of repose and colour for various food grains, fruits, vegetables, spices and processed foods, aerodynamic properties like terminal velocity, lift and drag force for food grains, thermal properties like thermal conductivity, thermal diffusivity and specific heat. Rheological properties: firmness and hardness of grain, fruits and stalk, electrical properties like dielectric constant, dielectric loss factor, loss tangent and A.C. conductivity of various food materials.

**PFE-509 Food Quality and Safety** **2+1** **Sem. II**

**Unit I** Food safety:Need for quality control and safety, strategy and criteria, microbiological criteria for safety and quality, scope of food toxicology, toxic potential and food toxicants, biological and chemical contaminants.

**Unit II** Food additives and derived substances, factors affecting toxicity, designing safety in products and processes, intrinsic factors, establishing a safe raw material supply, safe and achievable shelf life.

**Unit III** Process equipment and machinery auditing, consideration of risk, environmental consideration, mechanical quality control.

**Unit IV** Personnel hygienic standards, preventative pest control, cleaning and disinfesting system, biological factors underlying food safety.

**Unit V** Preservation and stability, contaminants of processed foods, adulteration, prevention and control, FSSAI, ISO, Codex, GMP, BIS and HACCP. Practices, principles, standards, specifications, application establishment and implementation, HACCP and quality management system.Food Safety Management Systems (FSMS), Traceability.

**Practical** : Microbiological examination of food, hazard analysis, premises design, HACCP project plan, CCP, CCP Decision tree, HACCP control chart. HACCP case studies: Survey, BIS, FPO, Codex standards and specifications. Visits to food industries to study the various quality and safety aspects adopted.

**PFE-510 Food Processing Technologies** **2+1** **Sem. II**

**Unit I** Mixing and homogenization: Principles of solid and liquid mixing, types of mixers for solids, liquid and pastes homogenization. Emulsification: Principles and equipment.

**Unit II** Novel dehydration technologies: Osmotic dehydration, foam mat drying, puff drying, freeze drying, microwave drying, dehumidified air drying. Extrusion: Theory, equipment, applications.

**Unit III** Non-thermal processing: Principles and equipment involved in ohmic heating, pulsed electric field preservation, hydrostatic pressure technique (vacuum processing, high pressure processing of Foods), ultrasonic technology, irradiation, quality changes and effects on microorganisms, nanotechnology in food processing.

**Unit IV** Distillation, leaching and extraction: Principles and equipment for distillation, crystallization, phase equilibria, multistage calculations, leaching principles and equipment, solvent extraction, super-critical fluid extraction, near critical fluid extraction: Equipment and experimental techniques used in NCF extraction and industrial application, advanced methods for extraction of food components and aroma recovery.

**Unit V** Food plant hygiene: Cleaning, sterilizing, waste disposal methods, Food processing plant utilities, steam requirements in food processing, HACCP in food processing industries.

**Practical** : Conducting experiments and solving problems on mixing and mixing indices, homogenization, distillation, crystallisation, extraction, leaching, membrane separation, reverse osmosis and ultrafiltration, design of plate and packed tower, visit to related food industry.

**PFE-511 Food Processing Equipment and Plant Design** **1+1** **Sem. II**

**Unit I** Design considerations of processing agricultural and food products.

**Unit II** Design of machinery for drying, milling, separation, grinding, mixing, evaporation, condensation, membrane separation.

**Unit III** Human factors in design, selection of materials of construction and standard component, design standards and testing standards. Plant design concepts and general design considerations: Plant location, location factors and their interaction with plant location, location theory models, and computer aided selection of the location.

**Unit IV** Feasibility analysis and preparation of feasibility report: Plant size, factors affecting plant size and their interactions, estimation of break-even and economic plant size. Product and process design, process selection, process flow charts, computer aided development of flow charts.

**Unit V** Hygienic design aspects and worker's safety, functional design of plant building and selection of building materials, estimation of capital investment, analysis of plant costs and profitability's, management techniques in plant design including applications of network analysis, preparation of project report and its appraisal.

**Practical** : Detailed design and drawing of mechanical dryers, milling equipment, separators, evaporators, mixers and separators. Each individual student will be asked to select a food processing plant system and develop a plant design report which shall include product identification and selection, site selection, estimation of plant size, process and equipment selection, process flow-sheeting, plant layout, and its evaluation and profitability analysis.

**PFE-512 Seed Process Engineering** **1+1** **Sem. I**

**Unit I** Processing of different seeds and their engineering properties, principles and importance of seed processing.

**Unit II** Performance characteristics of different unit operations such as precleaning, grading, conveying, elevating, drying, treating, blending, packaging and storage, seed processing machines like scalper, debreader, huller, velvet separator, spiral separator, cleaner-cumgrader, specific gravity separator, indent cylinder, disc separator, and colour sorter, seed treater, weighing and bagging machines, their operation and maintenance, installation and determination of their capacity, seed quality maintenance during processing, plant design and layout, economy and safety consideration in plant design.

**Unit III** Seed drying principles and methods, theory of seed drying, introduction to different types of heated air dryers, significance of moisture equilibrium, method of maintaining safe seed moisture, thumb rule and its relevance.

**Unit IV** Importance of scientific seed storage, types of storage structures to reduce temperature and humidity, management and operation/cleanliness of seed stores, packaging-principles, practices, materials and hermetic packaging, seed treatment methods and machines used, method of stacking and their impact, design features of medium- and long-term seed storage building.

**Practical** : Study of various seed processing equipment such as pre-cleaners, scalpers, air screen cleaners, graders, spiral and pneumatic separators, seed treating equipment, bag closures, scale etc. and their performance evaluation, design and layout of seed processing plant and its economics, analysis of cost of operation and unit cost of processed product, effect of drying temperature and duration of seed germination and storability.

**PFE-513 Agri-Project Planning and Management** **2+1** **Sem. I**

**Unit I** Project development, market survey and time motion analysis.

**Unit II** Selection of equipment, technology option, techno-economic feasibility and processing in production catchment.

**Unit III** Product and process design, PERT, CPM, transport model, simplex, linear and dynamic programming, operation log book. Material balance and efficiency analysis, performance testing,

performance indices, energy requirement and consumption. Marketing of agricultural products, market positioning.

**Unit IV** BIS/FSSAI/ISO standards/ guidelines on best practices, equipment and their design and operation for handling, processing and storage of food/feed.

**Practical** : Preparation of project and feasibility report. Salient features, design and layout of different food processing units: MSME, large processing unit. Record keeping related to production, finance and marketing. Techno- economic feasibility and SWOT analysis for Start-ups.

**PFE-514 Farm Structures and Environmental Control** **2+1** **Sem. I**

**Unit I** Farmstead planning, survey and data collection for information bank. Analysis of data, Lay outs. Cost estimation and appraisal. Project development: Time, motion and input analysis, flow charts and drawings and case studies.

**Unit II** Farm structures (farmstead, livestock, poultry, storage godowns, farm machinery storage, biogas, green house, net house etc), their design, constructional details and design of low-cost structures. Heating, ventilating and exhaust systems, air distribution and air cleaning, combustion of fuels and equipment.

**Unit III** Drying and dehumidification system, air-water contact operations and evaporation, process and product air conditioning, energy efficient environmental control practices. Rural electrification, households electric wiring, rural water supply and sanitation.

**Unit IV** Instruments and measurements: Codes and standards.

**Practical** : Calculation of heating and cooling load, design calculation of moisture condensation in agricultural buildings, study of moisture migration behaviour in storage bins, design aspect of green house, net house, septic tank, grain storage structures, cold storage.

**PFE-515 Dairy Product Processing** **2+1** **Sem. I**

**Unit I** Procurement, transportation and processing of market milk, cleaning and sanitization of dairy equipment. Special milks such as flavoured, sterilized, recombined and reconstituted toned and double toned.

**Unit II** Condensed milk: Methods of manufacture and related equipment, evaluation of condensed and evaporated milk. Dried milk: Definition, methods of manufacture of skim and whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder. Cream: Cream separation, neutralization, sterilization, pasteurization and cooling of cream, defects in cream, Butter: methods of manufacture, defects in butter.

**Unit III** Ice cream: Methods of manufacture and related equipment, defects in ice cream, technology of softy manufacture. Cheese: Methods of manufacture, cheddar, Gouda, cottage and processed cheese, defects in cheese.

**Unit IV** Indigenous milk products: Method of manufacture of yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand, chhana, paneer, ghee, lassietc.Probiotic milk product.

**Practical** : Estimation and fat and SNF in milk. Operation of LTLT and HTST Pasteurization. Preparation of special milks. Cream separation and standardization of milk. Preparation and evaluation of table butter, ice-cream, cheese and indigenous milk product such as khoa, chhana, paneer, ghee, rosogolla, gulabjamun, shrikhand, lassi, burfi etc. Visit to dairy plants.

**PFE-516 Processing of Meat, Poultry and Fish** **2+1** **Sem. II**

**Unit I** Meat: Genetic engineering of farm animals for better meat quality, automation for the modern slaughterhouse, hot-boning of meat, new spectroscopic techniques for online monitoring of meat quality, real-time PCR for the detection of pathogens in meat, new developments in decontaminating raw meat, automated meat processing, developments in chilling and freezing of meat, high pressure processing of meat, approaches for the development of functional meat products, new techniques for analyzing raw meat, modified atmosphere packaging, perspectives for the active packaging of meat products.

**Unit II** Poultry: Breeding and quality of poultry, stunning and slaughter of poultry, processing and packaging of poultry, new techniques of preservation of poultry, production of turkeys, geese, ducks and game birds, microbial hazards in poultry production and processing, latest trends in measuring quality of poultry and poultry products, treatment and disposal of poultry processing waste.

**Unit III** Fish and seafood: Fresh fish handling and chill storage, modified atmospheric packaging of seafoods, fish odours and flavours, assessment of freshness of fish and seafoods, traditional dried and salted fish products, proteolysed fish products, minced fish technology, retort pouch processing technology, irradiation and microwave in fish handling and processing, advanced freezing technology for fish storage, high pressure processing of seafoods, value addition of freshwater and aqua cultured fish products, application of enzymes in fish processing and quality control, toxins, pollutants and contaminants in fish and seafoods.

**Unit IV** Milk: Physical, chemical and nutritional properties of milk components, improvements in the pasteurization and sterilization of milk. Flavour generation in dairy products, controlling texture of fermented dairy products, functional dairy products, on-line measurement of product quality in dairy processing, high pressure processing of milk products, novel separation technologies to produce dairy ingredients, new technologies to increase shelf-life of dairy products, genetic engineering of milk proteins, production and utilization of functional milk proteins, methods of improving nutritional quality of milk, significance of milk fat in dairy products, chromatographic, spectrometric, ultrasound and other techniques for analysis of milk lipids.

**Practical** : Analysis of fresh and processed meat, fish, poultry and milk products, preservation of fresh meat and fish, processing and production of different products from fresh meat, fish and milk, shelf life studies on different meat, fish and milk products. Visit to processing plants.

**PFE-517 Design of Aquacultural Structures 2+1 Sem. I**

**Unit I** Inland fish farming and associated considerations.

**Unit II** Fish physiology and micro-climatic considerations. Site selection for aquaculture structures.

**Unit III** Design of dykes, sluice, channels etc. Aeration and feeding systems: Design of fish rearing structures, hatcheries, containers for live fish, fingerlings, fish seeds.

**Unit IV** Aquaculture in recirculatory systems, oxygen and aeration, sterilization and disinfection. Recirculation of water: Reuse systems, water exchange, design of re-use systems, Inlet and outlet structures and water treatment plants.

**Practical** : Aeration and feeding systems of fish ponds, fish farming structures, water treatment plants, containers for live fish. Design of re-use systems. Inlet and outlet structures.

**PFE-518 Thermal Environmental Engineering for Agricultural Processing 3+0 Sem. II**

**Unit I** Requirements of temperature and moisture in food preservation, processing, storage, animal and plant production systems, human comfort etc.

**Unit II** Thermodynamic properties of moist air, psychrometric chart, psychrometric processes and applications. Mass transfer and evaporation of water from free surfaces, theory of psychrometer, direct contact transfer processes between moist air and water-air washer, cooling tower, heating and cooling of moist air by extended surface coils, dehumidification using moisture absorbing materials. Solar irradiations on structures, calculation of heating and cooling loads in buildings/ storage structures.

**Unit III** Design of air conditioning systems, air distribution and duct design, air flow pattern and control, equipment, components and controls. Instruments for measurement and control of temperature and moisture.

**Unit IV** Thermal insulation materials for environmental control systems, applications of environmental control in green house, dairy industry, potato storage etc.

**PFE-519 Bioprocess Engineering** **2+1** **Sem. II**

**(For students of Department of Renewable Energy Engineering)**

**Unit I** Units and dimensions, mole concept, conventions in methods of analysis and measurement, temperature, pressure, the chemical equations and stoichiometry, limiting and excess reactant, Mass and energy balances in bioprocessesIntroduction to Fluid flow: Ideal and real fluids, Extensive and Intensive properties, viscosity, surface tension, capillarity, evaporability, vapor pressure, Newtonian and Non-Newtonian fluids

**Unit II** What is a bioprocess engineer? Overview of Biological Basics, kinetics of microbial growth and product formation. Methods of heat sterilization of media, thermal death kinetics, batch and continuous sterilization Different modes of operation of reactors, batch and continuous.

**Unit III** Enzymes: How Cells Work, Major Metabolic Pathways. Separation of solid from liquid: Classification of filters, various types of cake filters, principle of cake filtration, clarification filters, liquid clarification, centrifugal settling process.

**Unit IV** Mechanical agitation, power consumption in agitation, bubble aeration, transport phenomena in bioprocess systems; gas-liquid mass transfer, oxygen transfer to microbes and respiration, measurement of oxygen transfer coefficients, correlation between oxygen transfer coefficient and operating variables, factors affecting volumetric oxygen transfer.

**Practical** : Problem solving in units and dimensions, concentrations. Mass and energy balances in a process. Fluid statics and flow. Non-Newtonian fluids. Thermal process calculations. Calculations for heat exchanger. Filtration and sedimentation and mass transfer calculations.

**PFE-591 Seminar** **1+0**

**PFE-599 Master's Research** **0+30**

## Ph.D. courses

**PFE-601 Advances in Food Process Engineering** **2+1** **Sem. II**

**Unit I** Preservation of foods: Physical and chemical methods, microbiological aspects, thermo bacteriology, process calculation and selection. Thermal processing of canned foods: Introduction, commercial sterilization systems, thermal inactivation, kinetics of bacterial spores, heat transfer in canned foods, process calculations, numerical computer simulation of heat transfer, aseptic processing.

**Unit II** Low temperature preservation: Cooling and cold storage. Hurdle technology: Principles and applications. Food irradiation: Advantages and applications, beneficial chemical and biological effects on foods, mechanisms of food irradiation, sources of food irradiation, criteria for judging the efficacy, dosimetry, radiation tolerance of foods, upper irradiation dose for foods, safety of irradiated foods. Microwave processing: Interaction with food materials, microwave equipment. Hydrostatic pressure treatment of food: Equipment, processing and effect on microorganisms. High pressure processing: Introduction, equipment and operation principles. Chemical and thermodynamic principles. Applications of HP to foods. Commercial high pressure equipment and applications. Membrane concentration of liquid foods: Principles, thermodynamics and osmotic pressure, mechanisms of membrane transport, membrane transport models.

**Unit III** Application of heat energy and ultrasound: Effects of different environmental factors on microbial ultrasonic resistance, effects of treatment parameters on lethal effect of ultrasound, mechanism of action of inactivation of microorganisms and enzymes, cavitation. Electrical resistance heating of food: Heat generation. Ohmic heating and moderate electric field: Introduction, microbial death kinetics, electrolytic effects, applications, ohmic heater, heating models. Pulsed electric field preservation: Principles and application, microbial inactivation mechanism, determinant factors in PFE technology, influence on food ingredients, pulsed electric field treatment unit, modeling PFE microbial inactivation, alternative applications of PFE technology, decontamination of microorganisms by surface treatment.

**Unit IV** Extrusion cooking: Rheology of extrudates, Newtonian models of single-screw extruder performance, non-newtonian models of single-screw extruder performance, single-screw extruder leakage

flows, extruder die and its interaction with extruder behavior, screw power demand, non-isothermal screw operation, feed zone, behavior of more complex single-screw designs, multiple-screw extruders, partially filled screws, analysis of complex screws, heat transfer in extruders, extruder residence-time distributions, recent developments, methods, equipment, design criteria of extruders.

**Practical** : Thermal processing of foods, sterilization, irradiation, membrane concentration, ultrasound, ohmic heating, pulsed electric field preservation, extrusion cooking, product quality determination. Visit of related food industries.

**PFE-602 Drying and Dehydration of Food Materials 2+1 Sem. I**

**Unit I** Importance of drying, principles of drying, moisture determination, equilibrium moisture content, determination of EMC, methods and isotherm models. Psychrometry: Psychrometric terms, construction and use of psychrometric charts.

**Unit II** Air flow and resistance, principles and equipment for air movement and heating, drying methods and theory of drying, dryers, classification and other allied equipment, thin layer drying of cereal grains, deep bed and continuous flow drying, drying models.

**Unit III** Heat requirements and thermal efficiency of drying system, aeration, tempering and dehydration, operation of dryers and their controls, selection of dryers, performance testing of grain dryers, drying characteristics of cereals, pulses and oilseeds, microwave drying, radio frequency drying and tunnel drying, principles and equipment.

**Unit IV** Drying of liquid foods, spray drying, drum drying, freeze drying, foam mat drying, heat pump drying, refractance window drying, infrared drying osmotic dehydration. Principles, methods, construction and adjustments, selection of dryers, heat utilization factor and thermal efficiency.

**Practical** : Experiments on batch type thin layer dryer, fluidized bed dryer, continuous flow mixing type dryer, continuous flow non mixing type dryer, sand medium dryer (conduction type drying), agricultural waste fired furnace dryer, spray dryer, drum dryer, foam mat drying and osmotic dehydration to evaluate the thermal efficiency and heat utilization factor.

**PFE-603 Textural and Rheological Characteristics of Food Materials 2+1 Sem. I**

**Unit I** Rheological properties of foods: Food rheology, physical states of materials, classical ideal material, rheological models, elements in the models, electrical equivalence, maxwell model, Kelvin model and four element burger's model, stress-strain behavior. Elastic–plastic behavior, visco-elastic behavior, creep behavior, dynamic visco-elastic behavior, flow behavior of fluids, creep, stress relaxation.

**Unit II** Viscometry: Capillary viscometry, casson model, flow rate equation, friction losses in pumping, turbulent flow, newtonian fluid, power law fluid, cone and plate viscometry, parallel plate viscometry, mixer viscometry. Flow through a converging die, cogswell's equations, gibson's equations, empirical method. Applications of stress and strain, shear modulus and shear loss modulus, storage compliance and loss compliance, comparison of moduli and compliances.

**Unit III** Objective and subjective measurements of texture: Texture classification, relation of food texture with structure and rheology, principles and practices of objective or instrumental texture measurements, fundamental rheological tests, physiological aspects, mechanical aspects and viscosity measurements and relationship between fundamental tests and sensory evaluation. Imitative and empirical measurements of texture: Tenderometer, brabenderfarinograph, firmness meter, texture profile method, dynamic methods for evaluation of food texture, dimensional analysis of food texture, firmness and hardness measurement.

**Unit IV** Mathematical models and their application along with pipe line design and pump selection for non-newtonian fluids. Recent advances in textural, rheological and viscoelastic characteristics of foods and their associated mathematical models.

**Practical** : Determination of viscosity of liquid foods, gumminess, chewiness, springiness and hardness of various fruits, vegetables and processed foods using texture profile analysis. Determination of force-distance relationship. Sensory evaluation/ subjective measurement and correlation between subjective and objective measurements of foods.

**PFE-604 Agricultural Waste and By-Products Utilization** **2+1** **Sem. II**

**Unit I** Conversion processes: Thermo-chemical conversions, densification, combustion and gasification, extraction, biological conversions, anaerobic digestion, biochemical digestion process, digestion systems, energy from anaerobic digestion, cellulose degradation, fermentation process. Agricultural wastes as paper, boards and fuel.

**Unit II** Briquetting: Briquetted fuel from husk, hull and other wastes selection, design of briquetting machines. Utilization of shell, stem and stalk: Production of activated carbon. By-products of agro-industries: Rice mill, oil mill, cattle feed mill, valuable constituents and composition. Utilization of rice husk: Production of silica and cement from rice husk. Stabilization and storage of rice bran, extraction of rice bran oil.

**Unit III** By-products of oil refining: Fatty acids/soap stock, wax and gum, characteristics and utilization. Rice germ and broken rice. Production of starch and infant food, industrial uses of starch. By-products of oil milling: cake and defatted oil cake, cattle feed and industrial uses. Utilization of starch and other industrial wastes: Microcrystalline cellulose, production of ethanol, wastes of tapioca starch industries, thippi-utilization as fuel, extraction of starch by hydrolysis, utilization of starch for food, adhesives and feed purposes.

**Unit IV** By-products of sugar industry: Sugarcane tops, bagasse, molasses and pressmud, utilization as animal feed. By-products of fruits and vegetables based agro-industries: Mango seed kernel and pineapple waste.

**Practical** : Exercises on stepped grate and fixed grate rice husk furnaces, waste fired furnace, briquette machine, production of alcohol from waste materials, production and testing of paperboards and particleboards from agricultural wastes.

**PFE-605 Mathematical Modeling in Food Processing** **3+0** **Sem. II**

**Unit I** An overview of the modeling process. Introduction to mathematical, correlative and explanatory models. Formulation, idealization and simplification of the problems.

**Unit II** Probability models, series and linear mathematical approximation, dynamic and interacting dynamic processes.

**Unit III** Applications of mathematical modeling techniques to food processing operations like parboiling, convective drying, pasteurization, dehydration, shelf-life prediction, fermentation, aseptic processing, moisture diffusion, deep fat drying, microwave processing, infrared heating and ohmic heating.

**Unit IV** Stochastic finite element analysis of thermal food processes. Neural networks approach to modeling food processing operations.

**PFE-606 Advance Bioprocess Engineering** **2+1** **Sem. II**

**Unit I** Applications of engineering principles: Mass and energy balance, fluid flow principles, Unit operations of process engineering.

**Unit II** Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation.

**Unit III** Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors.

**Unit IV** Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon.

**Practical** : Kinetics of one substitute reactions, kinetics of growth in batch cultures, design consideration for bioreactors, media preparation and sterilization, microprocessor-based monitoring of bioprocess parameters.

**PFE-691 Seminar I** **1+0**

**PFE-692 Seminar II** **1+0**

**PFE-699 Ph.D Research** **0+75**

# SOIL AND WATER ENGINEERING

## A. IRRIGATION AND DRAINAGE ENGINEERING

### PROGRAMMES

### M. Tech.

### Ph.D.

### COURSE REQUIREMENTS

### M. Tech.

| | |
|---|---|
| Field of Specialization | Irrigation and Drainage Engineering |
| Required Courses | IDE-502, IDE-505, IDE-506 |
| Supporting Courses | Stat-502, Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem. |
| Minor Field | Farm Machinery and Power Engineering, Soil and Water Conservation Engineering, Remote Sensing and Geographic Information System, Agricultural Meteorology, Soil Science, Civil Engineering, Computer Science and Engineering, Mathematics, Statistics and Physics.<br>Any other course (s) of other department can be taken as per recommendations of the students advisory committee. |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by The Dean, Postgraduates Studies |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Irrigation and Drainage Engineering |
| Required Courses | IDE-601, IDE-602 |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Minor Field | Farm Machinery and Power Engineering, Soil and Water Conservation Engineering, Remote Sensing and Geographic Information System, Agricultural Meteorology, Soil Science, Civil Engineering, Computer Science and Engineering, Mathematics, Statistics and Physics.<br>Any other course (s) of other department can be taken as per recommendations of the students advisory committee. |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by The Dean, Postgraduates Studies |

## B. SOIL AND WATER CONSERVATION ENGINEERING

## PROGRAMMES

## M. Tech.

## Ph.D.

## COURSE REQUIREMENTS

### M. Tech.

| | |
|---|---|
| Field of Specialization | Soil and Water Conservation Engineering |
| Required Courses | SWCE-501, SWCE-502, SWCE-505 |
| Supporting Courses | Stat-502, Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem. |
| Minor Field | Farm Machinery and Power Engineering, Irrigation and Drainage Engineering, Remote Sensing and Geographic Information System, Agricultural Meteorology, Soil Science, Civil Engineering, Computer Science and Engineering, Mathematics, Statistics and Physics.<br>Any other course (s) of other department can be taken as per recommendations of the students advisory committee. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by The Dean, Postgraduates Studies |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Soil and Water Conservation Engineering |
| Required Courses | SWCE-601, SWCE-602 |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problem can be taken as per recommendations of the student's advisory committee. |
| Minor Field | Farm Machinery and Power Engineering, Irrigation and Drainage Engineering, Remote Sensing and Geographic Information System, Agricultural Meteorology, Soil Science, Civil Engineering, Computer Science and Engineering, Mathematics, Statistics and Physics.<br>Any other course (s) of other department can be taken as per recommendations of the students advisory committee. |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by The Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**SWE 102 Soil and Water Conservation Engineering** **1+1** **Sem. II**

**(For students of College of Agriculture)**

Introduction to soil and water conservation. Soil erosion: definition, causes and agents. Water erosion: forms of water erosion. Gully classification and control measures. Soil loss estimation by Universal Soil Loss Equation. Soil loss measurement techniques. Principles of erosion control: contouring, strip cropping, tillage practices, bunding and terracing. Grassed waterways and its maintenance.Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

**Practical:** General status of soil conservation in India. Calculation of erosion index. Estimation of soil loss.Measurement of soil loss.Preparation of contour maps.Study of grassed water ways, contour bunds, graded bunds and bench terracing system.

**SWE 201 Irrigation Engineering** **2+1** **Sem. I**

Purpose of irrigation, environmental impact of irrigation projects, sources of irrigation water. Major and medium irrigation schemes of India, present status of development and utilization of different water resources of the country. Measurement of irrigation water: weirs, flumes, orifices and other methods. Open channel water conveyance system: design and lining of irrigation field channels, on farm structures for water conveyance, control and distribution. Underground pipe conveyance system: components and design. Land grading: criteria, design methods and estimation of earth work. Soil-water-plant relationships: soil properties influencing irrigation water management, soil water potential, movement and infiltration, soil moisture characteristics, constants and their measurement, moisture stress and plant response. Water requirement of crops: concept, measurement and estimation of evapotranspiration (ET). Irrigation requirement: depth, frequency, duration and its efficiencies. Surface methods of water application: border, check basin and furrow irrigation, adaptability, specification and design considerations.

**Practical:** Measurement of soil moisture, irrigation water and infiltration characteristics using different instruments. Determination of bulk density, field capacity and wilting point of soil. Estimation of evapotranspiration (ET).Land grading methods. Design of underground pipeline system. Estimationof irrigation efficiencies. Study of advance, recession curve and computation of infiltration opportunity time. Infiltration by inflow-outflow method. Evaluation of border, furrow and check basin irrigation method.

**SWE 202 Soil and Water Conservation Engineering** **2+1** **Sem. II**

Soil erosion: definition, causes, types, agents and its effects. Water erosion: types, factors and its mechanics. Gully erosion: classification and stages of development. Soil loss estimation: Universal Soil Loss Equation (USLE) and modified USLE. Estimation of rainfall erosivity indices.Estimation of soil erodibility indices. Topography, crop management and conservation practice factors. Measurement of soil erosion: runoff plots and soil samplers. Rate of sedimentation, silt monitoring and storage loss in tanks. Water erosion control measures: agronomical measures (contour farming, strip cropping, conservation tillage and mulching), engineering measures (bunds and terraces, their types, planning, design, layout procedure and surplussing arrangements, contour stone wall and trenching. Ravine reclamation. Principles of gully control: vegetative measures and temporary structures, diversion drains. Grassed waterways and design. Wind erosion: factors affecting, mechanics, soil loss estimation and control measures (vegetative, wind breaks, shelter belts, mechanical measures and stabilization of sand dunes).

**Practical:** Study of different types and forms of water erosion. Computation of rainfall erosivity and soil erodibility indices.Determination of length of slope (LS) and cropping practice (CP) factors for soil loss on by USLE and modified USLE.Soil loss estimation/measuring techniques. Study of rainfall simulator for erosion assessment. Measurement of sediment rate using Coshocton wheel sampler and multi-slot devisor. Determination of sediment concentration through oven dry method. Design and layout of

contour bunds, graded bunds, broad base terraces and bench terraces. Design of vegetative waterways. Estimation of rate of sedimentation and storage loss in tanks. Computation of soil loss by wind erosion. Design of shelter belts and wind breaks for wind erosion control. Visit to watershed project areas for studying soil erosion and temporary control measures.

**SWE 203 Sprinkler and Micro Irrigation Systems** **1+1** **Sem. II**

Sprinkler irrigation: adaptability, types, problems and prospects. Sprinkler/micro sprinkler irrigation system design: steps, layout, selection, design of lateral, sub-main and main pipeline, selection of pump and power unit. Performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency. Micro irrigation system: types, merits and demerits, components. Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection, hydraulics and design steps. Steps for proper operation of a drip irrigation system. Maintenance of micro irrigation system: clogging, filter cleaning, flushing and chemical treatment. Fertigation: advantages, limitations, methods, fertilizers solubility and their compatibility, precautions, frequency, duration and injection rate. Economics: Cost estimation of sprinkler and micro irrigation system.

**Practical:** Study of different components, design and installation of sprinkler irrigation system. Determination of precipitation pattern, discharge and uniformity coefficient.Study of different components, design and installation of drip irrigation system. Determination of pressure discharge relationship and emission uniformity for emitter. Study of different types of filters and determination of filtration efficiency. Determination of rate of injection and calibration for chemigation/fertigation.Design of irrigation and fertigation schedule for crops.Field visit to micro irrigation system and evaluation of drip system. Cost economics of sprinkler and drip irrigation system.

**SWE 205 Water Management in Horticultural Crops** **1+1** **Sem. II**

**(For students of College of Horticulture and Forestry)**

Importance of water, water resources of India.Role of water in plant growth and development.Effect of moisture stress on crop growth.Distribution of soil moisture, water budgeting, rooting characteristics, moisture extraction pattern. Soil moisture constants and soil moisture characteristics curve. Water requirement of horticultural crops-lysimeter studies, climatological approach for estimation of crop ET, critical stages of crop growth for irrigation, irrigation scheduling and different approaches of irrigation scheduling. Various efficiencies in irrigation water management. Water measuring devices. Methods of irrigation-surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, quality of irrigation water, irrigation management practices for different soils and crops. Fertigation of horticultural crops.Layout of different irrigation systems, drip, sprinkler.Layout of underground pipeline system. **Practical:** Familiarization with various irrigation and drainage lab equipment's. Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices. Laser land levelling and land shaping implements, layout for different methods of irrigation.Estimation of soil moisture constants and soil moisture by using different methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments.Development of soil moisture characteristics curve. Determination of uniformity coefficient in drip and sprinkler irrigation. Estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices. Visit to irrigation systems in horticultural crops.

**SWE 301 Water Harvesting and Soil Conservation Structures** **2+1** **Sem. I**

Water harvesting: principles, importance and issues. Water harvesting techniques: classification based on source, storage and use. Runoff harvesting: short-term (terracing, bunding, rock and ground catchments) and long-term harvesting techniques, purpose and design criteria. Structures: farm ponds (dug-out and embankment type reservoir), tanks and subsurface dykes. Farm pond: types, components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond: site selection, design and construction details. Design considerations of nala bunds. Hydraulic jump and its application. Permanent structures for soil conservation and gully control: check dams, drop, chute and drop inlet spillway, design requirements and planning. Design procedures: hydrologic, hydraulic and structural design and stability analysis. Drop spillway: applicability,

types (straight drop and box-type inlet), description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway: description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway: description, functional use and design criteria.

**Practical:** Study of different types of farm ponds. Computation of storage capacity of embankment type of farm ponds. Design of dugout farm ponds, percolation pond and nala bunds. Runoff measurement using H-flume. Exercise on hydraulic jump and energy dissipation in water flow. Hydrologic, hydraulic and structural design of drop and drop inlet spillway and stability analysis of drop spillway.Design of SAF stilling basins in chute spillway and small earthen embankment. Practice on software's for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation structures.

**SWE 302 Drainage Engineering** **1+1** **Sem. I**

Water logging: causes and impacts. Drainage: objectives and familiarization with the drainage problems of the state. Surface drainage: purpose and benefits, drainage coefficient, types of surface drainage, design of surface drains. Sub-surface drainage: purpose and benefits, investigations of design parameters (hydraulic conductivity, drainable porosity, water table), derivation of Hooghoudt's and Ernst's drain spacing equations, design, layout, construction and installation of subsurface drainage system including mole drains. Drainage materials, envelope, pipes and structures. Vertical drainage: multiple well point system and bio-drainage. Salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.

**Practical:**In-situ measurement of hydraulic conductivity by single and inverse auger hole method. Estimation of drainage coefficients. Installation of piezometer and observation wells. Preparation of isobath and isobar maps. Determination of drainable porosity. Design of surface, subsurface drainage system and gravel envelope. Determination of chemical properties of soil and water.Study and fabrication of drainage tiles. Study of drainage pipes. Installation of sub-surface drainage system. Cost analysis of surface and sub-surface drainage system.

**SWE 303 Watershed Planning and Management** **2+1** **Sem. II**

Watershed: definition, delineation and characteristics. Watershed management: concept, objectives, factors affecting, watershed planning based on land capability classes, hydrological data for watershed planning and codification. Watershed development: problems and prospects. Bench mark surveys: overview of topographic survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Prioritization of watersheds: sediment yield index. Water budgeting in a watershed. Management measures: rainwater conservation technologies (in-situ and ex-situ storage and recycling). Dry land farming: moisture conservation techniques, inter-terrace and inter-bund land management. Integrated watershed management: concept, components, arable (agriculture, horticulture) and non-arable (forestry, fishery and animal husbandry) lands.Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme: execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management: concept, need and role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

**Practical:** Delineation of watersheds using toposheets. Preparation of watershed map. Quantitative analysis of watershed characteristics and parameters. Watershed investigations for planning and development. Analysis of hydrological data for planning watershed management. Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index. Study of functional requirement of watershed development structures, watershed management technologies and role of various functionaries in its development programmes. Practice on software for analysis of hydrological parameters of watershed. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas for planning and management. Case studies.

**SWE 304 Groundwater Wells and Pumps** **2+1** **Sem. II**

Occurrence and movement of groundwater. Aquifer and its types. Classification of wells: fully penetrating tubewells and open wells, familiarization of various types of bore wells. Design of open wells, tubewells and gravel pack. Groundwater exploration techniques. Methods of drilling of wells: percussion, rotary, reverse rotary. Types, selection and installation of well screen, completion and development of well. Groundwater hydraulics: determination of aquifer parameters by different methods such as Theis, Cooper-Jacob, Chow's and Theis recovery method. Well interference, multiple well systems. Estimation of groundwater potential and quality of groundwater. Artificial groundwater recharge techniques. Pumping systems: water lifting devices, types and classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics. Other pumps: hydraulic ram, propeller, mixed flow pumps and their performance characteristics. Deep well turbine and submersible pump.

**Practical:** Verification of Darcy's Law. Study of different drilling equipment's. Sieve analysis for gravel and well screens design. Estimation of specific yield and specific retention. Study/testing of well screen. Estimation of aquifer parameters by Theis, Cooper-Jacob, Chow and Theis Recovery method. Well design under confined and unconfined aquifer. Determination of well losses and efficiency. Estimation of groundwater balance. Study of artificial groundwater recharge structure. Study of radial and mixed flow centrifugal pumps, turbine, propeller and submersible/multistage pumps. Installation of centrifugal pump. Study of cavitation and hydraulic ram. Testing of centrifugal and submersible pump.

**SWE 305 Precision Farming and Protected Cultivation** **2+1** **Sem. I**

(For students of College of Horticulture and Forestry)

Precision farming – laser leveling, mechanized direct seed sowing; seedling and sapling transplanting, site specific input application. Protected cultivation technology: Introduction, techniques of protected cultivation, types of Greenhouses, Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Greenhouse equipment, materials of construction for traditional and low-cost greenhouses. Irrigation systems used in protected cultivation, Typical applications, passive solar greenhouse, hot air greenhouse heating systems, greenhouse drying. Cost estimation and economic analysis. Choice of crops for cultivation under protected structures, problems/constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics.

**Practical:**Laser leveling procedure and field visit. Study and field visit for mechanized direct seed sowing and transplanting. Study of different types of greenhouses based on shape, construction and cladding materials. Studies on different environment control parameters in greenhouses. Estimation of drying rate of agricultural products inside greenhouse.Testing of soil and water to study its suitability for growing crops in protected structures. The study of fertigation requirements for greenhouse crops and estimation of E.C and pH in the fertigation solution. The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization/sterilization. Visit to commercial protected cultivation structures. Economics of protected cultivation.

## Elective Courses

**SWE 401 Floods and Control Measures** **2+1** **Sem. II**

Floods: causes of occurrence, classification (probable maximum flood, standard project flood and design flood) and estimation methods. Estimation of flood peak: rational and unit hydrograph method and empirical methods. Statistics in hydrology: flood frequency methods (log normal, Gumbel's extreme value, log-Pearson type-III distribution) and depth-area-duration analysis. Flood forecasting. Flood routing: channel and reservoir routing, Muskingum and modified Pul's method. Flood control: history, structural and non-structural measures, storage and detention reservoirs, levees and channel improvement. Spurs: types, functions, location and construction. Gully erosion and control structures: design and implementation. Ravine control measures. River training works, planning of flood control projects and their economics. Earthen embankments: functions, classification, hydraulic fill and rolled fill

dams(homogeneous, zoned and diaphragm type), foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line, drainage filters, piping and its causes. Design and construction of earthen dam, stability of earthen dam against failure by tension, overturning, sliding. Stability of slopes and analysis of failure by different methods. Subsurface dams: site selection and constructional features. Check dam: small earthen embankments (types and design criteria).

**Practical:** Determination of flood stage-discharge relationship in a watershed, flood peak-area relationships, frequency distribution functions for extreme flood values using Gumbel's method, confidence limits of the flood peak estimate for Gumbel's extreme value distribution, frequency distribution functions for extreme flood values using log-Pearson Type-III distribution, probable maximum flood, standard project flood and spillway design flood. Design of levees and jetties for flood control.Study of vegetative and structural measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost-benefit analysis of a flood control project.Study of different types, materials and design considerations of earthen dams. Determination of the position of phreatic line in earthen dams for various conditions. Stability analysis of earthen dams against head water pressure, foundation shear and sudden draw down condition. Stability of slopes of earthen dams by friction circle and other methods. Construction of flow net for isotropic and anisotropic media. Computation of seepage by different methods. Determination of settlement of earthen dam.Input-output-storage relationships by reservoir routing. Visit to sites of earthen dam and water harvesting structures.

**SWE 402 Wasteland Development** **2+1** **Sem. II**

Land degradation: concept, classification, arid, semi-arid, humid and sub-humid regions, denuded rangeland and marginal lands. Wastelands: factors, classification and mapping of wastelands, planning of waste lands development, constraints, agro-climatic conditions, development options and contingency plans. Conservation structures: gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods. Afforestation: agro-forestry, agro-horti, silvi-pastural methods, forage and fuel crops, socioeconomic constraints, shifting cultivation and optimal land use options. Wasteland development: hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands. Mine spoils: impact, land degradation, reclamation and rehabilitation, slope stabilization and mine environment management. Micro irrigation in wasteland development. Sustainable wasteland development: drought situations and socio-economic perspectives. Government policies. Participatory approach. Preparation of proposal for wasteland development and benefit-cost analysis.

**Practical:** Mapping and classification of wastelands. Identification of factors causing wastelands. Estimation of vegetation density and classification. Planning and design of engineering measures for reclamation of wastelands. Design and estimation of different soil and water conservation structures under arid, semi-arid and humid conditions. Planning and design of micro irrigation in wasteland development. Cost estimation of the soil and water conservation measures. Visit to wasteland development project sites.

**SWE 403 Information Technology for Land and Water Management** **2+1** **Sem. II**

Concept of Information Technology (IT) and its application potential.Role of IT in natural resource management. Existing system of information generation and organizations involved in the field of land and water management. Application and production of multimedia Internet application tools and web technology Networking system of information.Problems and prospects of new information and communication technology.Development of database concept for effective natural resource management. Application of remote sensing, geographic information system (GIS) and GPS for land and water resource management. Relational data base management system. Object oriented approaches. Information systems, decision support systems and expert systems. Agricultural information management systems: use of mathematical models and programmes. Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management. Video-conferencing of scientific information.

**Practical:** Multimedia production. Internet applications: e-mail, voice mail, web tools and technologies. Handling and maintenance of new information technologies and exploiting their potentials. Exercise on database management using database and spreadsheet programmes. Usage of remote sensing, GIS and GPS survey in information generation and processing. Exercise on running computer software

packages dealing with water balance, crop production, land development, land and water allocation and watershed analysis. Exercise on simple decision support and expert systems for management of natural resources. Multimedia production using different software's. Exercise on development of information system on selected theme(s). Video-conferencing of scientific information.

**SWE 404 Remote Sensing and Geographic Information System 2+1 Sem. II**

Remote sensing: introduction, components, advantages and limitations. Characteristics of electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface, major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water, spectral signatures, different types of sensors and platforms. Contrast ratio and possible causes of low contrast. Aerial photography: types, scale, planning (end lap and side lap), stereoscopic vision, requirements of stereoscopic photographs, air-photo interpretation and its elements. Photogrammetry: measurements on a single vertical aerial photograph, measurements on a stereo-pair (vertical measurements by the parallax method), ground control for aerial photography. Satellite remote sensing: multispectral scanner (whiskbroom and push-broom scanner) and types of resolutions. Analysis of digital data: image restoration, enhancement, information extraction and classification (unsupervised and supervised). Important consideration in the identification of training areas. Vegetation indices. Microwave remote sensing. GIS: components, spatial entities, sources and components of spatial data. Map projections and their properties. Methods of data input into GIS, data editing, spatial data models and structures, attribute data management and integrating data (map overlay) in GIS. Application of remote sensing and GIS for the management of land and water resources.

**Practical:** Familiarization with remote sensing and GIS. Use of software for image interpretation. Interpretation of aerial photographs and satellite imagery. GIS operations such as image display.Study of various features of GIS software package.Scanning, digitization of maps and data editing. Data base query and map algebra. GIS supported case studies in water resources management.

**SWE 405 Design and Management of Canal Irrigation System 2+1 Sem. II**

Purpose, benefits and ill effects of irrigation. Network of canal irrigation system and its different physical components, canal classification based on source of water, financial output, purpose, discharge and alignment. General considerations for canal alignment. Performance indicators for canal irrigation system evaluation. Estimation of water requirements for canal command areas and determination of canal capacity. Duty, base period, delta and their relationship, factors affecting duty and its improvement. Silt theory: Kennedy's and Lacey's regime theory, equations and design of channel by Kennedy's and Lacey's theory. Maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandi. Canal lining: necessity, advantages and disadvantages, types and desirable characteristics for the suitability of lining materials. Design of lined canals, functions of distributary head and cross regulators, canal falls, their necessity and factors affecting canal fall. Channel crossing structures. Sources of surplus water in canals and types of canal escapes, requirements of a good canal outlet and types of outlets.

**Practical:** Estimation of water requirement of canal commands. Determination of canal capacity. Layout of canal alignments on topographic maps, drawing of canal sections in cutting, full banking and partial cutting and banking. Determination of longitudinal section of canals. Design of irrigation canals based on silt theories. Design of lined canals. Formulation of warabandi. Study of canal outlets, regulators, escapes and canal falls.

**SWE 406 Minor Irrigation and Command Area Development 2+1 Sem. II**

Classification of irrigation projects, factors affecting performance and types of minor irrigation systems in India. Development and utilization of water resources through different minor irrigation schemes. Lift irrigation systems: feasibility, type of pumping stations, site selection and design. Tank irrigation: grouping of tanks, storage, supply works and sluices. Command area development (CAD) programme: components, need, scope and development approaches, historical perspective, CAD authorities functions and responsibilities, on farm development and reclamation works and use of remote sensing techniques for CAD works. Water productivity: concepts, measures for enhancing productivity and Farmers' participation in CAD.

**Practical:** Preparation of command area development layout plan. Irrigation water requirement of crops. Preparation of irrigation schedules. Planning and layout of water conveyance system. Design of surplus weir of tanks. Determination of storage capacity of tanks. Design of intake pipe and pump house.

**SWE 407 Precision Farming Techniques for Protected Cultivation 2+1 Sem. II**

Protected cultivation: introduction, components, perspective, types and cladding materials. Plant environment interactions: principles of limiting factors, solar radiation, transpiration, greenhouse effect, light, temperature, relative humidity and carbon dioxide enrichment. Design and construction of greenhouses: site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system and equipment used. Greenhouse cooling system: necessity, methods (ventilation with roof and side ventilators, evaporative cooling), shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems and pad care. Greenhouse heating: necessity, components, methods and design of heating system. Earth-Heat-Exchange within greenhouse condition and thermal behaviour of greenhouse. Root media: types (soil and soil less media), composition, estimation, preparation, disinfection and bed preparation. Planting techniques in green house cultivation. Design and installation of irrigation system: water quality, types, components, design, installation and material requirement and maintenance. Fogging system: introduction, benefits, design, installation material requirement and maintenance. Fertilization: nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, rate of fertilizer application, methods, scheduling and automated fertilizer application. Greenhouse climate measurement. Study of different greenhouse environment control instruments. Insect and disease management in greenhouse and net houses. Selection of crops for greenhouse cultivation. Major crops in greenhouse: irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques. Economic analysis.

**Practical:** Estimation of material requirement for construction of greenhouse and root media. Root media preparation, bed preparation and disinfections. Study of different planting techniques. Design and installation of irrigation and fogging system. Greenhouse heating. Study of different greenhouse environment control instruments. Operation, maintenance and fault detection in irrigation and fogging system. Determination of fertilization schedule and rate of application for various crops. Economic analysis of greenhouses and net houses. Visit to greenhouses.

**SWE 408 Water Quality and Management Measures 2+1 Sem. II**

Water resources and quality issues in India. Natural factors affecting quality of surface and groundwater, water quality in relation to domestic, industrial and agricultural activities. Drinking water quality standards, irrigation water quality classification as per US Salinity Laboratory (USSL) and All Indian Coordinated Research Project (AICRP) criteria. Point and non-point water pollution sources. Water contamination due to inorganic, organic compounds, agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures. Water decontamination technologies, cultural and management practices for using poor quality water for irrigation.

**Practical:** Water quality analysis and classification according to USSL and AICRP criteria. Soil chemical analysis and estimation of lime and gypsum requirements. Study of salinity development under shallow and deep-water table conditions, contaminant movement and transport in soil profile. Study of water decontamination techniques and cultural and management practices for using poor quality water for irrigation. Field visit to industrial effluent disposal sites.

**SWE 409 Landscape Irrigation Design and Management 2+1 Sem. II**

Conventional method of landscape irrigation: hose irrigation, quick release coupling and portable sprinkler system with hose pipes. Modern methods of landscape irrigation: pop-up and spray pop-up sprinklers, shrub adopter, drip irrigation and bubblers. Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, segments and main components of modern landscape irrigation systems and their selection criteria. Merits and demerits of conventional and modern irrigation systems. Types of pipes, pressure ratings, sizing and selection criteria. Automation

system for landscape irrigation: main components, types of controllers and their applications. Design, operation and maintenance of modern landscape irrigation systems.

**Practical:** Study of irrigation equipment for landscapes. Design and installation of irrigation system for landscape. Determination of water and power requirements for pump selection. Irrigation scheduling of landscapes. Study of irrigation controllers and other equipment. Use of Auto CAD in irrigation design: blocks and symbols, head layout, zoning and valves layout, pipe sizing and pressure calculations. Visit to landscape irrigation system and its evaluation.

**SWE 410 Plastic Applications in Agriculture** **2+1** **Sem. II**

Introduction of plasticulture: types and quality of plastics used in soil and water conservation, production agriculture and post-harvest management, quality control measures. Present status and future prospective of plasticulture in India. Water management: use of plastics in in-situ moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir. Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Drip and sprinkler irrigation systems.Use of polymers in control of percolation losses in fields. Soil conditioning: soil solarisation, effects of different colour plastic mulching in surface covered cultivation. Nursery management: use of plastics in nursery raising, nursery bags and trays. Controlled environmental cultivation: plastics as cladding material, green/poly/shade net/net houses, wind breaks, poly tunnels and crop cover. Plastic nets for crop protection: anti insect and bird protection nets. Plastic fencing.Plastics in drying, preservation, handling and storage of agricultural produce, cover and plinth (CAP) storage for food grains.Use of plastics as alternate material for manufacturing farm equipment and machinery.Plastics for aqua cultural engineering and animal husbandry (animal shelters, vermi-beds and inland fisheries).Silage film technique for fodder preservation. Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticulture applications.

**Practical:** Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds. Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals.Study of different plastic mulch laying methods. Design, estimation and installation of green/poly/shade net/net houses and low tunnels. Study on cover and plinth (CAP) storage for food grain storage, innovative packaging solutions (leno bags, crates, bins, boxes and vacuum packing, unit packaging, controlled atmosphere (CA) and modified atmosphere packaging (MAP)) and cost estimation. Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder preservation. Study of plastic parts in making farm machinery.Visits to manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, green/poly/shade net/nethouse and farmers' fields with these installations.

## Postgraduate Courses

### Irrigation and Drainage Engineering (IDE)

**IDE-501 Design of Surface Irrigation Systems** **1+1** **Sem. I**

**Unit I** Climate and irrigation water requirement. Irrigation principles, losses, conveyance, distribution, application and water budgeting. Estimation techniques of effective rainfall. Irrigation software's: CROPWAT, QUACROP.

**Unit II** Farm irrigation systems. Irrigation efficiencies. Economic feasibility. Irrigation water quality and salinity management techniques. Design of water conveyance, control and distribution systems.

**Unit III** Hydraulics: Design and operation of border, check basin, furrow, sprinkler and trickle irrigation systems. Flow dynamics, drop size distribution and spray losses in sprinklers. Cablegation, surge and bubbler irrigation. Automation of irrigation system.

**Unit IV** Basic water management concepts and objectives. Alternative irrigation scheduling techniques. Integrated approach to irrigation water management.

**Practical** : Design and evaluation of border, furrow, check basin, sprinkler and micro-irrigation. Computation of frictional losses. Design of underground water conveyance systems. Economics of irrigation methods. Visit to mechanized farms.

**IDE-502 Design of Farm Drainage Systems** **2+1** **Sem. I**

**Unit I** Salt affected waterlogged areas in India. Water quality criteria and brackish water use for agriculture. Drainage requirements and crop growth under salt affected waterlogged soil.

**Unit II** Concept of critical water table depth for waterlogged soil and crop growth. Drainage investigations and drainage characteristics of various soils. Methods of drainage system and drainage coefficient.

**Unit III** Theories and applications of surface and subsurface drainage. Planning, design and installation of surface and subsurface drainage systems for waterlogged and saline soils. Theories and design of vertical drainage, horizontal subsurface drainage and multiple well point system. Drainage materials.

**Unit IV** Steady and unsteady state drainage equations for layered and non-layered soils. Principle and applications of Hooghoudt, Kirkham, Earnst, Glover Dumm, Kraijenhoff van de Leur equations. Drainage for salinity control.

**Unit V** Salt balance, leaching requirement and management practices under drained conditions. Disposal of drainage effluents. Case study for reclamation of salt affected waterlogged areas.

**Practical** : Measurement of in-situ hydraulic conductivity. Estimation of drainage coefficient and leaching requirements. Delineation of waterlogged areas through isobar, isobath and topographic maps. Design of surface and subsurface drainage systems. Design of filter and envelop materials.

**IDE-503 Command Area Management** **2+1** **Sem. I**

**Unit I** Concept of command area development (CAD) as an integrated approach. Command area project formulation, major, medium and minor projects. Command areas in India, command area activities and their prioritization. Source of budget for CAD works. Structure of command area development, organization, role and responsibilities of command area development authority (CADA).

**Unit II** Laser based land grading survey and leveling in command areas. Design of lined and unlined canals. Diversion head works and canal head regulators, cross drainage works, canal falls, canal breaches. Design of on farm water distribution network, operation and maintenance of canal.

**Unit III** Assessment and appraisal of water availability in command areas. Water management problems in command areas and their possible remedies. Duty of water, its determination and factors affecting it. Methods of improving duty of canal water. Feasibility of drip irrigation in irrigated command areas.

**Unit IV** Single and multi-objective command area planning for the better management and allocation of irrigation water. Conjunctive use of canal water and groundwater. Real time canal irrigation scheduling.

**Unit V** Canal performance indices. Diagnostic analysis and perform appraisal of command area projects. Water user's association (WUA)–functions, problems encountered during formation of WUA and strategy and overcome the problems. Participatory irrigation management (PIM) efforts and strategy for preparing PIM. Socio-economic aspects of irrigation management in command areas.

**Practical** : Study of canal, tank and tube well in a command area. Study of design and operational parameters of a command area. Study of water balance in a command. Study the impact of command area project on crop yield and environment. Conflict resolution through Participatory Rural Appraisal (PRA) exercise. Diagnostic analysis of the problems of command area through PRA and field observations. Analysis of equity in water distribution. Considerations for preparation of roistering schedules. Study of the functioning of irrigation cooperatives/water user's associations. Preparation of command area development plan.

**IDE-504 Water and Nutrient Management under Protected Cultivation** **2+1** **Sem. I**

**Unit I** Significance of soilless culture in agriculture. Functions of the root system. Response of root growth to local nutrient concentrations. Interactions between environmental conditions and form of 'N'nutrition.

**Unit II** Roots as source and sink for organic compounds and plant hormones. Physical and chemical properties of soilless media.

**Unit III** Water content and water potential in soilless media. Water movement in soilless media. Uptake of water by plants in soilless media and water availability.

**Unit IV** Production technology for vegetables under protected conditions in soil and soilless media. Automation for climate control in protected structures. Thermal modeling of greenhouse environment for protected cultivation.

**Practical** : Filter types and its selection criteria. Design and installation of drip irrigation system for vegetables and orchards. Irrigation and fertigation scheduling for vegetables and horticultural. Study of different types of sensors, relay and control mechanism for controlled irrigation and fertigation. Design of automated system for irrigation and fertigation. Design and installation of different protected structures as per the guidelines of National Horticulture Mission (NHM). Design and fabrication of soilless medium for crop/flower production. Economical evaluation of automated irrigation system and soilless medium for crop/flower production.

**IDE-505 Design of Drip and Sprinkler Irrigation Systems 2+1 Sem. II**

Unit I Suitability of sprinkler and drip irrigation systems under Indian conditions. Basic hydraulics of sprinkler and micro irrigation system.

**Unit II** Pipe flow analysis. Friction losses and pressure variation. Flow in nozzles and emitters.

**Unit III** Design and evaluation of sprinkler and micro irrigation systems in relation to source, soil, climate and topographical conditions.

**Unit IV** Selection of pipe size, pumps and power units. Layout, distribution, efficiency and economics.

**Unit V** Fertigation through sprinkler and micro irrigation systems. Fertigation techniques involved in drip and sprinkler irrigation system.

**Practical** : Design of drip and sprinkler irrigation system. Calculation of total head. Determination of uniformity of sprinkler discharge at field. Numerical on hydraulics of dripper. Calculation of different types of efficiencies of installed drip system. Calculation of cost benefits of drip and sprinkler irrigation system.

**IDE-506 Ground Water Engineering 2+1 Sem. I**

**Unit I** Water resources of India. Occurrence, storage and movement of groundwater in alluvial and hard rock formations. Principles of groundwater flow. Interaction between surface water and groundwater.

**Unit II** Natural and artificial groundwater recharge. Conjunctive use of surface and groundwater. Groundwater balance. Fluctuation of water table beneath a recharge site. Delineation of groundwater potential zones using Remote Sensing and Geographic Information System (RS&GIS), MODFLOW equation.

**Unit III** Derivation of hydraulics of fully and partially penetrating wells in confined, leaky and unconfined aquifers. Flow net analysis.

**Unit IV** Analysis of multi aquifers. Flow analysis in interfering wells. Pumping tests for estimation of aquifer parameters. Wells near recharge and impermeable boundaries. Skimming well technology.

**Unit V** Design of well field. Salt water intrusion in inland and coastal aquifers. Application of groundwater models for groundwater management. Calibration and validation of models.

**Practical** : Water table contour maps and determination of groundwater flow. Estimation of aquifer characteristics. Problems on non-leaky and leaky aquifers. Analysis of pumping test data. Computation of interference of wells. Groundwater computer simulation models.

**IDE-507/SWCE-507Remote Sensing and GIS for Land and Water Resource Management 2+1 Sem. II**

**Unit I** Physics of remote sensing. Electromagnetic radiation (EMR), interaction of EMR with atmosphere, earth surface, soil, water and vegetation. Remote sensing platforms: Monitoring atmosphere, land and water resources: LANDSAT, SPOT, ERS, IKONOS and others. Indian Space Programme.

**Unit II** Satellite data analysis.Visual interpretation. Digital image processing. Image pre-processing. Image enhancement. Image classification. Data merging.

**Unit III** Basic components of GIS. Map projections and co-ordinate system. Spatial data structure: Raster, vector. Spatial relationship. Topology. Geo-database models: Hierarchical, network, relational, object-oriented models. Integrated GIS database. Common sources of error. Data quality: Macro, micro and Usage level components, Meta data. Spatial data transfer standards.

**Unit IV** Thematic mapping. Measurement in GIS: Length, perimeter and areas. Query analysis. Reclassification, Buffering and Neighborhood functions. Map overlay: Vector and raster overlay. Interpolation and network analysis. Digital elevation modeling. Analytical Hierarchy Process. Object oriented GIS, AM/FM/GIS and Web Based GIS.

**Unit V** Spatial data sources. 4M GIS approach water resources system. Thematic maps.Rainfall runoffmodeling, groundwater modeling and water quality modeling.Flood inundation mapping and modeling.Drought monitoring.Cropping pattern change analysis. Performance evaluation of irrigation commands. Site selection for artificial recharge.Reservoir sedimentation.

**Practical** : Familiarization with the remote sensing instruments and satellite imagery. Aerial Photograph and scale determination with stereoscope. Interpretation of satellite imagery and aerial photograph. Determination of Parallaxes in images.Introduction to digital image processing software and GIS software and their working principles. Generation of digital elevation model (DEM) for land and water resource management. Case studies on mapping, monitoring and management of natural resources using remote sensing and GIS.

**IDE-508 Wastewater Management and Utilization in Agriculture 2+1 Sem. I**

**Unit I** Status of wastewater in India.Sources of contamination and characterization of urban and rural wastewater for irrigation. Water quality: Physical, chemical and biological parameters of wastewater.

**Unit II** Water quality requirement: Potable water standards, wastewater effluent standards, water quality indices. Irrigation water quality standards and guidelines for their restricted and unrestricted uses. Selection of appropriate forestry trees, fruits, vegetables, oilseeds and food grain crop for wastewater utilization.

**Unit III** Control measures for preventing soil and other surface/groundwater source contamination. Different types of waste waters, pollutants and contaminants. Impact of wastewater on ecosystem, eutrophication, biomagnification, water borne diseases.

**Unit IV** Wastewater treatment methods: Physical, chemical and biological. General water treatments: Wastewater recycling, constructed wetlands, reed bed system. Carbon foot prints of wastewater reuse. Environmental standards.

**Unit V** Regulation and environmental impact assessment (EIA): Environmental standards-Central Pollution Control Board (CPCB) Norms for discharging industrial effluents to public sewers. Stages of EIA-Monitoring and Auditing Environmental clearance procedure in India.

**Practical** : Measurement of water quality indices in the lab.Field demonstration of impact of wastewater on eco-system and human health Wastewater treatment methods and effect of wastewater in contamination of ground water. Visit of wastewater treatment plant near by area.

**IDE-509 Water Conveyance and Distribution 2+1 Sem. II**

**Unit I** Channel characteristics. Prismatic and non-prismatic channel. Steady, unsteady, uniform and non-uniform flow. Open channel and their properties. Energy and momentum, critical flow computation and application. Basic Concepts of free surface flow, classification of flow, velocity and pressure distribution.

**Unit II** Uniform flow, conservation laws and specific energy. Application of momentum and energy equation. Channel transition. Study of critical flow, uniform flow, gradually varied flow, rapid varied flow, spatially varied flow and unsteady flow and their computations.

**Unit III** Energy dissipation. Flow control structures and flow measurement. Theories and methods of open channel design.

**Unit IV** Sediment transport in channels. Regime flow theories. Tractive force theory. Design of stable channels.

**Unit V** Basic principles of pipe flow, pipe flow problems and equivalent pipe. Principles of network synthesis. Pipe network analysis. Water transmission lines. Cost considerations: Single-Input source. Branched systems: Single-Input source. Looped Systems: Multi-Input source. Branched systems: multi-Input source, Looped systems. Decomposition of a large water system and optimal zone size.

**Practical** : Computation and use of geometrical and hydraulic elements of open channel. Use of flow measuring devices and methods and their limitations. Examination of velocity distribution and calculation of energy and momentum coefficients. Solution of channel design problems. Appraisal of flow control and distribution structures. Analysis and computation of flow profiles.

**IDE-510 Minor Irrigation** **2+1** **Sem. I**

**Unit I** Definition, scope, historical background and progress in minor irrigation works in India, Assessment of surface water resource. Design and operation of surface water storage structures.

**Unit II** Evaporation and seepage control. Groundwater development methods and their scope. Groundwater extraction devices and methods. Aquifer characteristic and their evaluation. Wells in alluvial and rocky aquifers.

**Unit III** Well interference, spacing and multiple well point system for controlled groundwater pumping. Safe yield from wells. Augmentation of well yield through pumping and recovery time management.

**Unit IV** Well design, drilling and construction. Tube well strainers, gravel packing and resistance to flow. Pumps and prime movers for groundwater lifting. Diagnosis of sick and failed wells and their remediation.

**Unit V** Conjunctive use of surface and groundwater. Legislation for groundwater development and management. Groundwater recharge and its use.

**Practical** : Measurement of seepage loss from reservoirs. Estimation of inflow to surface reservoir. Measurement of evaporation loss from surface reservoirs. Pumping test and determination of aquifer parameters. Establishment of draw down-discharge characteristic. Well log analysis and deciding on length and placement of strainers. Computation of well interference and deciding on well spacing. Estimation of irrigation for given discharge from well. Estimating pumping cost for irrigation. Analysis of ground water quality. Problems on well design.

**IDE-511 Design of Pumps for Irrigation and Drainage** **2+0** **Sem. II**

**Unit I** Basic hydraulic design of centrifugal pump. Net positive suction head and cavitation, vapour pressure, water hammering problem in centrifugal pump.

**Unit II** Principles and design of pumping systems for agricultural drainage. Selection and performance of characteristics of vertical turbine pump, submersible pump and axial flow pump.

**Unit III** Multiple well point system and their design. Energy requirement in groundwater pumping.

**Unit IV** Non-conventional energy sources for pumping, wind mills, micro turbines, solar pumps. Hydraulic ram: Selection and design criteria. Solar photovoltaic system.

**Unit V** Design of pumping station. Techno-economic evaluation. Efficient pumping system operation, flow control strategies and conservation measures for pumping systems.

**IDE-512 Crop Environmental Engineering** **2+0** **Sem. II**

**Unit I** Principles of heat, mass and momentum transport. Transport of radiant energy, radiation environment, micro climatology of radiation. Micrometeorology: Turbulent transfer profiles and fluxes. Interpretation of flux measurement. Laws of electromagnetic radiation, its measurement and estimation.

**Unit II** Profile balance of heat, mass and momentum in and above crop communities. Climatic changes and plant response to environmental stresses. Measurement and estimation of potential evapotranspiration on point and regional scale.

**Unit III** Root anatomy, water flow in roots and root density models (microscopic and macroscopic). Stem anatomy and pressure volume curves. Methods of measuring water status in plants. Estimating evapotranspiration (ET) using three temperature model and MODIS algorithm. Soil–Plant–Atmosphere system: Basic properties. Dynamics of water movement. ET-yield relations.

**Unit IV** Principles of optimal scheduling of irrigation and seasonal allocation of limiting water supplies using Linear Programming (LP) and Dynamic Programming (DP). Seasonal and dated production functions. Crop yield modeling and condition assessment Instrumentation and techniques for monitoring plant environments.

**Unit V** Design and operation of controlled environment facilities and their instrumentation. Climatic changes and plant response to environmental stresses. Evapotranspiration models.

**IDE-513 Water Resources Systems Engineering 2+1 Sem. I**

**Unit I** Concepts and significance of optimization in water resources management. Model development in water management. Objective functions, deterministic and stochastic inputs.

**Unit II** Soil plant atmosphere system. Problem formulation. Mathematical programming techniques: Linear programming, simplex method.

**Unit III** Non-linear programming, quadratic programming, integer programming. Transportation problem and solution procedure. Geometric programming and dynamic programming.

**Unit IV** Application of optimization techniques for water resources planning. Conjunctive use of water resources. Crop production functions and irrigation optimization.

**Unit V** Multi objective water resources planning. Critical path method. Programme evaluation and review technique. Economic models. Project evaluation and discounting methods.

**Practical** : Assessment of water resources. Problems related to water allocation in agriculture under single and multiple cropping system. Use of computer software for linear and dynamic programming. Introduction to the use of other programming methods. Sensitivity analysis of different alternatives of water resources development and allocation. Analysis of water demand and supply. Analysis of competitive demands for water by various sectors of development. Benefits and cost of water resources development.

**IDE-514 Irrigation Economics Planning and Management 2+0 Sem. II**

**Unit I** Economic analysis Problems in project selection Methods and approaches to water pricing. Criteria for investment and pricing in irrigation projects. Social benefits, problems and causes of under-utilization. Mathematics of economic analysis. Cost allocation, separable and non-separable costs. Discounting factors and techniques. Determination of benefits, cost and benefit analysis. Project evaluation Limitations of benefit-cost analysis Dynamics of project analysis.

**Unit II** Role of financial analysis Distinctions from economic analysis. Financial feasibility and analysis. Impact of public policies on regulation and allocation of irrigation water Relative economic efficiency of alternative irrigation water management models Irrigation system improvement by simulation and optimization to enhance irrigation water use efficiency.

**Unit III** Indian agriculture, main problems, population, government policies, systems, organizing agriculture production. Farm Management: Definition, importance, scope, relation with other sciences and its characteristics.

**Unit IV** Socio-economic survey. Importance of such survey in planning, implementation and evaluation of project performance. Planning of socio-economic survey, types of data sets to be collected, preparing the questionnaires form, schedules sampling, editing and scrutinizing of secondary data, classification and analysis of data.

**Unit V** Role of farm management principles in decision making for irrigated agriculture. Decision making process, assessing risk and uncertainty in planning.

**IDE-515 Sensing and Automation in Irrigation Systems 3+0 Sem. II**

**Unit I** Sensing and sensors. Sensor classifications. Wireless sensor networks. History of wireless sensor networks (WSN). Communication in a WSN. Important design constraints of a WSN like Energy, self-management, wireless networking, decentralized management, design constraints, security etc.

**Unit II** Node architecture. Sensing subsystem. Analog-to-Digital converter. The processor subsystem, architectural overview, microcontroller, digital signal processor, application specific integrated circuit, field programmable gate array (FPGA).

**Unit III** Communication interfaces, serial peripheral interface, inter-integrated circuit, the IMote node architecture, The XYZ node architecture, the Hogthrob node architecture.

**Unit IV** Applications in surface irrigation automation, automation based on volume, time, fertigation scheduling, water logging, salinity, oxygen diffusion systems, etc.

**IDE-591 Seminar** **1+0**

**IDE-599 Master's Research** **0+30**

## Ph.D. courses

**IDE-601 Recent Developments in Irrigation Engineering** **2+1** **Sem. II**

**Unit I** Geospatial analysis of hydraulic properties of the soil. Surge flow irrigation systems. One dimensional and two-dimensional zero inertia modeling of border irrigation, surge irrigation and furrow irrigation. Integral equation solutions to surface irrigation. Design of irrigation runoff recovery systems. Cablegation: Automated supply for surface irrigation. Analyzing wind distortion in sprinkler irrigation systems uniformity.

**Unit II** Design of sub-surface drip irrigation systems. Modeling soil water regimes and solute distribution emanating from surface and sub-surface drip irrigation systems. Recent developments in designs of surface and sub-surface drip irrigation systems. Effects of emitter variability and plant and soil variability on soil moisture distribution uniformity. Irrigation scheduling through partial root zone irrigation. Low energy drip irrigation systems.

**Unit III** Drip irrigation for poor quality water. Drip automation for time and volume. Drip irrigation system modification for wastewater utilization. Modeling deficit irrigation and crop yield in response to hydraulic variation of the system and distribution uniformity of the soil-crop water fertilizer response function. Crop water salinity response function.

**Unit IV** Drip irrigation in command area development. Mulching and its effect on crop productivity. Analyzing moisture and temperature profiles with time and depth. Effect of shading and mulching on crop productivity, vapour phase movement.

**Practical** : Designing border irrigation using zero inertia model, volume balance approaches, evaluating surge flow irrigation systems, operation of segmented border irrigation systems for enhancing water use efficiency, geospatial analysis of soil properties, design and planning of surface drip irrigation systems using various designs, design of subsurface drip irrigation, analyzing three-dimensional moisture movement under subsurface drip irrigation using simple empirical models, design and planning of surface and subsurface drainage systems, developing the irrigation schedules using partial root zone irrigation, seasonal and dated production functions for forecasting crop yield.

**IDE-602 Advances in Drainage Engineering** **2+1** **Sem. II**

**Unit I** Physics of land drainage Forces, surface tension and energy effects water Energy of soil water. Capillary potential.

**Unit II** Devices to measure capillary potential. Hysteresis, Darcy's law. Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems.

**Unit III** Laplace equation its derivation and solution in various forms. Boundary value problems, Linear flow laws.

**Unit IV** Drainage criteria saturated flow theory, steady flow and non-steady flow. Controlled drainage for reducing agricultural non-point pollution. Application of simulation models for drainage systems.

**Unit V** Flow equations in general and the approach. Flow problem and physical boundary conditions.

**Practical** : Steady state and non-steady state flow problems. Measurement of capillary potential. Use of various synthetic materials under the field condition. Use of simulated models for drainage system.

**IDE-603 Hydro-Mechanics and Groundwater Modeling** **3+0** **Sem. I**

**Unit I** Concept of soil aquifer system, flow of water in partially saturated soils. Partial differential equation of flow, pressure under curved water films, moisture characteristic functions.

**Unit II** Physical models, Analog models, Mathematical modeling, Unsaturated flow models, Numerical modeling of groundwater flow, Finite difference equations and solutions.

Successive over relaxation. Alternating direction implicit procedure. Crank Nicolson equation. Iterative methods. Direct methods. Inverse problem. Finite element method.

**Unit III** Determination of unsaturated hydraulic conductivity and model for its estimation. Diffusivity and its measurement. Infiltration and exfiltration from soils in absence and presence of water table.

**Unit IV** Fence diagram and aquifer mapping. Movement of groundwater in fractured and swelling porous media. Spatial variability, theory of krigging.

**Unit V** Data requirements. Conceptual model design: Conceptualization of aquifer system. Parameters, Input-output stresses, Initial and Boundary conditions. Model design and execution: Grid design, Setting boundaries, Time discretization and transient simulation. Model calibration: Steady state and unsteady state. Sensitivity analysis. Model validation and prediction. Uncertainty in the model prediction.

**IDE-604 Soil-Water-Plant-Atmospheric Modeling** **2+1** **Sem. I**

**Unit I** Radiation balance of earth's surface.Turbulent transport of heat and momentum. Radiation exchange and heat transfer in a low plant cover.

**Unit II** Measurement of radiation, leaf and air temperature, humidity and wind profiles within plant cover. Predicting potential evapotranspiration.

**Unit III** Thermodynamics of flow through plant cells. Dynamics of water movement through soil plant atmosphere system. Stomatal aperture, photosynthesis and actual evapotranspiration relationship.

**Unit IV** Production functions of evapotranspiration. Evapotranspiration in mathematical modeling and optimization of design and regulation of irrigation systems and for utilization of limited water resources in agriculture.

**Unit V** Crop water requirement under protected cultivation and remote sensing-based modeling.

**Practical** : Estimation of potential evapotranspiration Measurement of evapotranspiration (ET) parameters under open and protected cultivation and development of stochastic and deterministic models of ET.Use of software for estimation of crop water requirement and ET.

**IDE-605 Plant Growth Modeling and Simulation** **2+0** **Sem. I**

**Unit I** Introduction to plant growth modeling. Simulation and simulation language. Types of models and modeling approaches.

**Unit II** Relational diagram of principle process. Structure of a generalized agricultural simulator. Input environment and techniques for monitoring plant environment.

**Unit III** Process and aspects of growth and development. Input yield models. Quantitative analysis of photosynthesis, respiration, growth, water and nutrient uptake. Yield functions.

**Unit IV** Remote sensing-based modeling and field variability of growth influencing factors.

**IDE-606 Multi Criteria Decision Making System** **2+0** **Sem. I**

**Unit I** Introduction: Multi criteria decision making (MCDM): overview, basic foundations and Pareto optimality elementary decision analysis. Decision trees and influence diagrams.

**Unit II** Multi–attribute decision making (MADM): Deterministic utility theory, value decomposition, additive value decomposition, Multi–facility location analysis, expected utility theory, single attribute utility functions, multi–attribute overview, two–attribute utility models, multi–attribute computer programs, multi–attribute assessment.

**Unit III** Multi–objective decision making (MODM): Vector optimization theory, weighting methods, weighting example. Linear vector optimization (LVOP), parametric decomposition, LVOP algorithm, LVOP example.

**Unit IV** Non interactive and interactive methods: Geoffrion's Bicriterion method, linear goal programming, nonlinear and integer goal programming.

**Unit V** Interactive trade–off methods: Zionts–Wallenius, Surrogate worth, Group decision making methods.

**IDE-691 Seminar I** **1+0**

**IDE-692 Seminar II** **1+0**

**IDE-699 Ph.D Research** **0+75**

# Soil and Water Conservation Engineering (SWCE)

**SWCE-501 Advanced Soil and Water Conservation Engineering 2+1 Sem. I**

**Unit I** Concept of probability in design of soil and water conservation structures. Probability and continuous frequency distribution. Fitting empirical distributions.

**Unit II** Relevance of soil and water conservation in agriculture and in the river valley projects. Layout and planning of soil and water conservation measures. Software's for design of conservation structures.

**Unit III** Productivity loss due to soil erosion. Water stress and water excess. Types and mechanics of soil erosion. WEAP, EPIC software's for soil loss estimation**.**

**Unit IV** Theories of sediment transport. Control of runoff and sediment loss. Sediment deposition process Estimation of sediment load.

**Unit V** Design of soil and water conservation structures: Check dams, gully plugs, gabion structures, earth dams, silt detention dams, farm ponds, etc., and the alternate use of the stored water for agriculture. Application of Remote Sensing and GIS in Soil and Water Conservation.

**Practical** : Assessment of erosive status of a watershed through field measurement or analysis of morphometric properties. Estimation of erosivity index of rainfall. Determination of soil physical properties: Texture, grain size distribution, Atterberg's limits, various moisture percentages. Locating best possible sites of soil and water conservation structures on the basis of map features and erosivity status. Estimation of costs of soil and water conservation measures.

**SWCE-502 Applied Watershed Hydrology 2+1 Sem. I**

**Unit I** Hydrology in water resources planning, rainfall, surface runoff and sub-surface runoff as components of hydrologic cycle. Runoff phenomena, relationship between precipitation and runoff. Stream flow measurement and analysis of data in detail.

**Unit II** Synthetic unit hydrograph. Recent advances in analysis of hydrologic data and flow from small watersheds. Methods of runoff estimation from small watersheds. Use of IUH and various methods of estimation. Runoff estimation models: SCS, CN software.

**Unit III** Micro climate, estimation methods of evaporation. Advances and improvements in rational approach. SCS approach criticism and improvements.

**Unit IV** Hydrological hazard functions. Methods of estimation of hydrologic parameters. Data transformation.

**Unit V** Calibration and evaluation of hydrologic models. Computer simulation of hydrological process in small watersheds.

**Practical** : Delineation of watershed and study of watershed characteristics. Measurement of rainfall and runoff in a watershed and data analysis. Estimation of infiltration and runoff from a watershed. Analysis and derivation of various types of hydrographs Flood routing Reservoir sedimentation Watershed model components. Visit to a watershed.

**SWCE-503 Soil and Water Conservation Structures 2+1 Sem. II**

**Unit I** Design, planning and layout of soil and water conservation structures. Criteria of selection of appropriate structures as per soil, land use and climatic conditions.

**Unit II** Design and construction of earthen dam, stability analysis of land slopes and soil mass including landslides.

**Unit III** Hydrological and structural design including stress analysis. Hydraulic jump and energy dissipaters for soil conservation structures.

**Unit IV** Seepage through dams, flow net and determination of uplift pressure in drop structures, design of energy dissipaters.

**Unit V** Design of water harvesting structures, construction, maintenance and utilization of stored water Mechanized construction techniques for soil and water conservation structures.

**Practical** : Numerical approach on probability distribution functions. Stability analysis and structural design of masonry water harvesting structures. Design of earthen dams and other energy dissipating structures. Cost analysis of water harvesting structures. Field visit to already constructed water harvesting structures in the nearby area/watershed.

**SWCE-504 Stochastic Hydrology** **2+1** **Sem. I**

**Unit I** Hydrologic cycle, Systems concept, Hydrologic systems model. Classification of hydrologic models, Statistical, stochastic and deterministic approaches. Statistical characteristics of hydrological data, probability distribution of hydrologic variables. Deterministic and stochastic hydrology, Cause and effect analysis. Hydrologic time series analysis– nature, stationarity and ergodicity, components of time series, trend, periodicity and stochastic parts, parameter estimation of probability distributions. Analysis of hydrologic extremes.

**Unit II** Multivariate regression analysis, correlation analysis, correlation coefficient and its significance in regional analysis. Developing prediction equation by simple and multiple linear regression. Reliability of the Model.

**Unit III** Stochastic Process: Classification, stationary process. Time series: Classification, component of time series. Methods of investigation: Auto correlation coefficient, moving average process, auto regressive process, auto regressive moving average process, auto regressive integrated moving average process. Spectral analysis, analysis of multivariate hydrologic series.

**Unit IV** Thomas Fiering model, Box Jenkins model. Model formulation: Parameter estimation, calibration and validation. Application to hydrologic data. Generation and forecasting. Regional flood frequency analysis. Transformations, Hypothesis testing.

**Unit V** Modeling hydrologic uncertainty. First order Markov process, Markov chain, Data generation, Hydrologic time series analysis, Modeling of hydrologic time series.

**Practical** : To estimate various statistical parameters of the hydrologic variables, estimating missing data in historical series, various parameter estimation methods like method of moments, method of maximum likelihood, method of mixed moments, probability of weighted moments fitting discrete and continuous distribution functions to variables, application of transformation techniques to historical data for estimating variables at different return periods, determining correlation and regression coefficients, analyzing multivariate regression, autocorrelation coefficient for independent and correlated events, fitting ARMA models, fitting Markov models of first and second order, regional frequency analysis, time series analysis of the historical data, estimating and fitting Thomas Fiering Model.

**SWCE-505 Watershed Management and Modeling** **2+1** **Sem. II**

**Unit I** Concept of watershed, its hydrological and geomorphological characteristics. Status of watershed management programs in India. Problems of desertification and degradation.

**Unit II** Concept of watershed management and sustainability, participatory approach and operational watershed. Surveys, monitoring, reclamation and conservation of agricultural and forest watersheds, hill slopes and ravines.

**Unit III** Watershed management research instrumentation and measurement, problem identification, simulation and synthesis. Rainfed farming and drought management. Modeling of flood and drought phenomenon.

**Unit IV** Use of Remote Sensing and GIS in watershed management and modeling. Watershed modeling approaches, mathematical bases and structure of existing watershed models.

**Unit V** Environmental impact assessment of watersheds. Quantitative evaluation of management techniques. National land use policy, legal and social aspects. Case studies of watershed management.

**Practical** : Selection and delineation of a watershed. Benchmark surveys. Preparation of watershed land use map. Preparation of watershed development proposal. Preparation of watershed evaluation and

impact assessment report. Application of watershed models for evaluation of conservation treatments. Use of Remote Sensing and Geographic Information System in watershed management and modeling.

**SWCE-506 Flow Through Porous Media** **2+0** **Sem. I**

**Unit I** Aquifer and fluid properties, forces holding water in soils, hydrodynamics in porous media and limitations of governing laws.

**Unit II** Differential equations of saturated flow, initial and boundary conditions. Dupuit and Boussinesq approximations and linearization techniques.

**Unit III** Stream functions, potential functions and flow net theory. Analysis of seepage from canals and ditches.

**Unit IV** Unsaturated flow theory, Infiltration and capillary rise flux dynamics. Movement of groundwater in fractured and swelling porous media.

**Unit V** Hydro-dynamic dispersion in soil-aquifer system. Velocity hydrograph, flow characteristics at singular points, examples of velocity hydrograph, solution by complex velocity, solution of triangular dam, drainage in retaining structures, influence of seepage on stability of slopes, drainage methods for stability of slopes.

**SWCE-507/ IDE-507Remote Sensing and GIS for Land and Water Resource Management 2+1 Sem. II**

**Unit I** Physics of remote sensing, electromagnetic radiation (EMR), interaction of EMR with atmosphere, earth surface, soil, water and vegetation. Remote sensing platform, monitoring atmosphere, land and water resources: LANDSAT, SPOT, ERS, IKONOS and others, Indian Space Programme.

**Unit II** Satellite Data analysis: Visual interpretation, digital image processing, image pre-processing, image enhancement, image classification and data merging.

**Unit III** Definition: Basic components of GIS, map projections and co-ordinate system, spatial data structure-raster, vector, spatial relationship, topology, geo-database models, hierarchical network, relational, object-oriented models, integrated GIS database-common sources of error–data quality: Macro, micro and usage level components, meta data, Spatial data transfer standards.

**Unit IV** Thematic mapping, measurements in GIS: Length, perimeter and areas. Query analysis, reclassification: Buffering, neighbourhood functions, map overlay: Vector and raster overlay: Interpolation, network analysis, digital elevation modeling. Analytical Hierarchy Process, Object oriented GIS–AM/FM/ GIS, Web Based GIS.

**Unit V** Spatial data sources: 4M GIS approach water resources system, Thematic maps, rainfall runoff modeling, groundwater modeling, water quality modeling and flood inundation mapping and modeling. Drought monitoring, cropping pattern change analysis, performance evaluation of irrigation commands. Site selection for artificial recharge, reservoir sedimentation.

**Practical** : Familiarization with the Remote sensing instruments and satellite imagery. Aerial Photograph and scale determination with stereoscope. Interpretation of satellite imageries and aerial photographs. Determination of Parallaxes in images. Introduction to digital image processing software and Geographic Information System software and their working principles. Generation of digital elevation model (DEM) for land and water resource management. Case studies on mapping, monitoring and management of natural resources using remote sensing and Geographic Information System.

**SWCE-508Climate Change and Water Resources** **3+0** **Sem. II**

**Unit I** The climate system: Definitions, climate, climate system, climate change. Drivers of climate change, characteristics of climate system components: Greenhouse effect, carbon cycle, wind systems. Trade winds and the Hadley Cell, ozone hole in the stratosphere, El Nino, La Nina– ENSO, teleconnections.

**Unit II** Impacts of climate change: Observed and projected, global and Indian scenario, observed changes and projected changes of Intergovernmental panel on climate change (IPCC): Impacts on water resources, NATCOM Report, impacts on sectoral vulnerabilities, Special report of emissions scenario (SRES), different scenarios, climate change impacts on ET and irrigation demand.

**Unit III** Tools for vulnerability assessment: Need for vulnerability assessment, steps for assessment, approaches for assessment. Models: Quantitative models, Economic models, impact matrix approach, Box models, Zero-dimensional models, Radioactive-convective models, Higher dimension models, EMICs (Earth-system models of intermediate complexity), GCMs (global climate models or general circulation models), Sectoral models.

**Unit IV** Adaptation and mitigation water: Related adaptation to climate change in the fields of ecosystems and biodiversity, agriculture and food security, land use and forestry, human health, water supply and sanitation, infrastructure and economy (insurance, tourism, industry and transportation), Adaptation, vulnerability and sustainable development.

**Unit V** Sector specific mitigation: Carbon dioxide capture and storage (CCS), bio-energy crops, biomass electricity, hydropower, geothermal energy, energy use in buildings, land-use change and management, cropland management, afforestation and reforestation. Potential water resource conflicts between adaptation and mitigation. Implications for policy and sustainable development.

**Case studies** : Water resources assessment case studies: Ganga Damodar Project, Himalayan glacier studies, Ganga valley project. Adaptation strategies in assessment of water resources. Hydrological design practices and dam safety, operation policies for water resources projects. Flood management strategies, drought management strategies, temporal and spatial assessment of water for irrigation, land use and cropping pattern, coastal zone management strategies.

**SWCE-509Numerical Methods in Hydrology** **2+0** **Sem. II**

**Unit I** Review of finite difference operators. Concept of linear space and basis functions. Approximating from finite dimensional sub spaces.

**Unit II** Variational and weighted residual methods. Langrange polynomials. Triangular and quadrilateral shape functions.

**Unit III** Isoparametric elements and transformation of coordinates. Basis functions in three dimensions.

**Unit IV** Galerkin finite element solution of Laplace, diffusion and dispersion-convection equations.

**Unit V** Method of collocation, application in surface and subsurface hydrology.

**SWCE-510Dryland Water Management Technologies** **2+0** **Sem. I**

**Unit I** Drought severity assessment: Meteorological, hydrological and agricultural methods. Drought indices. GIS based drought information system, drought vulnerability assessment and mapping using GIS. DPAP programme, drought monitoring constraints, limiting crop production in dry land areas. Types of droughts, characterization of environment for water availability, crop planning for erratic and aberrant weather conditions.

**Unit II** Stress physiology and crop resistance to drought, adaptation of crop plants to drought, drought management strategies. Preparation of appropriate crop plans for dry land areas. Mid contingent plan for aberrant weather conditions.

**Unit III** Land shaping and land development for soil moisture conservation. Improvement of tillage and soil management by implements and engineering practices. Soil and moisture conservation for rainfed lands through improved implements and engineering practices. Gel technology. Ex-situ measures: Water harvesting-micro catchments. Design of small water harvesting structures: Farm Ponds, percolation tanks their types and design, recycling of runoff water for crop productivity.

**Unit IV** Crops and cropping practices related to soil and moisture conservation. Fertility management in dryland farming. Planning and development of watersheds from engineering view point. Case studies.

**Unit V** Application of aerial photography in surveys and planning of watersheds for rainfed agriculture. Use of Remote Sensing in soil moisture estimation.

**SWCE-591 Seminar** **1+0**

**SWCE-599 Master's Research** **0+30**

## Ph.D. courses

**SWCE-601Advances in Hydrology** **2+1** **Sem. II**

**Unit I** Hydrologic models, processes and systems. Uncertainty in hydrological events.Statistical homogeneity.

**Unit II** Probabilistic concept.Frequency analysis.Probability distribution of hydrological variables. Confidence intervals and hypothesis testing.

**Unit III** Simple and multiple linear regressions, correlation, statistical optimization and reliability of linear regression models.Analysis of hydrologic time series and modeling. Auto–correlation, correlogram and cross-correlation analysis.

**Unit IV** Markov processes, stochastic hydrologic models including Markov chain models. Generation of random variates.Hydrology of climate extremes. Area-duration-frequency curves. Regional flood frequency analysis.

**Unit V** Formulation of various steps involved in formulation of statistical models and their application in hydrology.

**Practical** : Parametric and non-parametric test of time series data. Development of probabilistic and deterministic models for time series data of rainfall and runoff. Development of hydrologic models and frequency analysis for specified data set using SPSS and other software used in hydrologic modeling.

**SWCE-602 Soil and Water Systems Simulation and Modeling** **2+1** **Sem. II**

**Unit I** Models and their classification, simulation procedure. Rainfall-runoff models. Infiltration models, evapo-transpiration models, structure of a water balance model.

**Unit II** Overland and channel flow simulation. Modeling approaches and parameters. Stream flow statistics Surface water storage requirements.

**Unit III** Flood control storage capacity and total reservoir capacity. Surface water allocations Palaeo channels Ground water models.

**Unit IV** Design of nodal network. General systems frame work. Description of the model. Irregular boundaries Decision support system using simulation models Monte-Carlo approach to water management.

**Unit V** Stanford watershed model and input data requirements of various hydrologic modeling systems. Soil water assessment tool (SWAT). Groundwater modeling and solute transport.

**Practical** : Rainfall - runoff models. Infiltration models. Stanford watershed model (SWM). Channel flow simulation problems. Stream flow statistics. Model parameters and input data requirements of various software's of surface hydrology and groundwater. Hydrologic modeling system. Soil water management model. Soil water assessment tool (SWAT). Catchment's simulation hydrology model Stream flow model and use of dimensionless unit hydrograph Generalized groundwater models.

**SWCE-603 Reservoir Operation and River Basin Modeling** **2+1** **Sem. I**

**Unit I** Water resources system analysis: Techniques, concept, objectives and applications.

**Unit II** Identification and evaluation of water management plans. Demand analysis, policy formulation. Water resources planning objectives. Water resources planning under uncertainty.

**Unit III** Definition of terminologies and basic concepts. Theories and principles of Integrated river basin management (IRBM)processes/phases in integrated river basin management. River basins, river functions. Human interventions and impacts River basins in India, related case studies. Water resources planning in river basins Operational management, tools and methods. Monitoring, acquisition and processing of water resource data.

**Unit IV** Statistical methods Decision support systems. Deterministic river basin modeling. Stream flow estimation, estimating reservoir storage, mass diagram analysis, sequent peak analysis, single and multi-reservoir operation models Economics and finance.

**Unit V** Stochastic river basin modeling: Single reservoir design and operation, multisite river basin models, stochastic linear programming operation models.

**Practical** : Development of regression models, stochastic models and deterministic models for river basin based on stream flow data. Estimation of reservoir storage and preparation of operation models.

**SWCE-604 Modeling Soil Erosion Processes and Sedimentation 2+1 Sem. I**

**Unit I** Mechanics of soil erosion Erosion-sedimentation systems of small watersheds Overland flow theory and simulation Basic theory of particle and sediment transport. Sediment deposition processes.

**Unit II** Modeling upland erosion and component processes. Modes of transport and transport capacity concept and computation. Channel erosion. Erosion and sediment yield measurement and estimates.

**Unit III** Reservoir sedimentation surveys and computation. Classification of models, structure and mathematical bases of sediment yield models. Nature and properties of sediment: Individual and group of particles. Critical tractive force, lift and drag forces. Shield's analysis.

**Unit IV** Calibration and testing of models. Universal soil loss equation, its modification and revisions. Stochastic and dynamic sediment yield models.

**Unit V** Evaluation of erosion control measures. Computer models used for hydrologic and/or watershed modeling.

**Practical** : Computation of soil erosion index Estimation of soil erodibility factor. Design of erosion control structures. Computation of suspended load and sediment load using empirical formulae. Application of sediment yield models. Prediction of sediment loss. Computation of reservoir sedimentation, sounding method.

**SWCE-605 Wastewater Treatment and Utilization 3+0 Sem. I**

**Unit I** Types of wastewater, causes of pollution, analysis of pollutants in the waste effluents, biological wastewater treatment, biological sludge treatment. Biological systems: Fundamentals of microbiology and biochemistry, bioenergetics and metabolism, kinetics of biological growth. Process analysis: Reaction rates, effect of temperature on reaction rate, enzyme reaction and kinetics, effect of temperature on reaction rate. Reactor analysis, residence time distribution.

**Unit II** Sewerage system: Domestic wastewater characteristics, flow equalization, population equivalent, treatment flow chart. Primary, secondary and tertiary treatment of domestic wastewater. Downstream wastewater treatment for reuse and recycle. Need for downstream processing. Guidelines for wastewater recycling Small and package plants for wastewater treatment.

**Unit III** Activated sludge process: Substrate utilization and biomass growth, Monod's kinetics, estimation of kinetic parameters. Process Description and its Modification, Process design, process performance evaluation, trouble shooting. Nitrogen removal-Biological nitrification and denitrification.

**Unit IV** Activated sludge process design for nutrient removal. Process operation: Food-to-microorganism (F/M),mean cell residence time, oxygen requirement. Biological and chemical phosphorus removal, Sedimentation of activated sludge. Advanced activated sludge process-Sequencing Batch reactor, Oxidation ditch and membrane bioreactors.

**Unit V** Biofilm process: Trickling filter, bio tower, rotational biological contactor, integrated activated sludge and biofilm processes. Stabilization ponds and aerated lagoons: Types and their description, design, operation and maintenance. Anaerobic processes: Process description, process design, operation and maintenance, sludge digestion. Sludge treatment thickening, dewatering-mechanical and sludge drying beds. Utilization of in agriculture and other sectors.

**SWCE-606 Hydro-Chemical Modeling 2+0 Sem. I**

**Unit I** Review of hydrodynamics in flow through porous media. Miscible displacement, physical processes.

**Unit II** Breakthrough curves and mathematical models for miscible displacement. Hydrodynamic dispersion convection equations and its solutions.

**Unit III** Statistical models for dispersion. Gaseous ($CO_2$ and $O_2$) diffusion equation.

**Unit IV** Heat flow through soil by conduction. Concept of adsorption in solute transport.

**Unit V** Analytical and numerical models of contaminant transport in unsaturated soil profile and groundwater aquifers.

**SWCE-691 Seminar I** **1+0**

**SWCE-692 Seminar II** **1+0**

**SWCE-699 Ph.D Research** **0+75**

# REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

**PROGRAMME**

**M.Tech.**

**(In collaboration with Punjab Remote Sensing Centre)**

**COURSE REQUIREMENTS**

**M. Tech.**

| | |
|---|---|
| Field of Specialization | Remote Sensing and Geographic Information System |
| Required Courses | RSGIS-501, RSGIS-502, RSGIS-503 |
| Supporting Courses | Stat.-502, Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem. |
| Minor Field | Computer Science and Engineering, Soil and Water Conservation Engineering, Soil Science, Irrigation and Drainage Engineering, Agricultural meteorology.<br>Any other course(s) of other department can be taken as per recommendations of the students advisory committee. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by The Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

**RSGIS-501 Principles of Remote Sensing** **2+1** **Sem. I**

**Unit I** Overview of Remote Sensing: Definition of terms, Concepts and Types of remote sensing, Electro Magnetic Radiation, spectrum, sources of EMR, Interaction of EMR with the atmosphere and targets& atmospheric windows

**Unit II** Imaging spectroscopy and Spectral signatures of various land cover features Principles of visual interpretation and keys for visual interpretation, Techniques of visual interpretation. Types of Platforms

**Unit III** Orbit of satellite Kepler law, Satellite characteristics. Satellite for earth observation Imaging Modes, Types and Classification of Sensors, Characteristics of Optical Sensor, Sensor Resolutions-Spatial, Spectral, Temporal and Radiometric Data reception and Transmission, data quality, Global and Indian Data Products, Errors types and Sources, Radiometric, Geometric and Atmospheric errors

**Unit IV** Principles of Microwave Remote Sensing, air craft radar system, SLAR-components, wave lengths range and azimuth resolution, Micro wave sensors and image characteristics and interpretation

**Unit V** Emissivity of different data products, Characteristics of Images and different types of available data products, Thermal Image Interpretation, Hyper-spectral Remote sensing

**Practical** : Satellite Image Annotation and Referencing Scheme. Digital Referencing Scheme. IR Thermal Radiation Measuring Instruments and drawing of Isotherms and plotting diurnal variation curve. Understanding of Spectral Response Pattern of different Land cover objects. Ground Data collection instruments, Radiometers, Spectrometers etc. and Ground Data collection in a given area with the help of Radiometers and Spectrometers.

**RSGIS-502 Geomatics, Geodesy and GPS** **2+1** **Sem. I**

**Unit I** Components and functions of GIS, Data types and spatial data models, Spatial data and attribute data, their sources, Geographical data formats. Digitizing

**Unit II** Spatial Data quality and uncertainty. Non Spatial Database Creation, Database design using RDBMS, Vector & raster based analysis: Single and multi- layer raster and vector analysis, map overlay, Spatial Join, Buffering analysis, network analysis, optimum path, multi criteria analysis.

**Unit III** Cloud GIS, Free and Open source tools and web resources, Decision support systems

**Unit IV** Introduction to geodesy and its development, Earth and its size, shape, motions. Earth and its gravity field and its atmosphere, temporal variations, gravitational field of the atmosphere.

**Unit V** GPS working principle and history, Types of receivers; GPS satellite Signals, Accuracy and error sources. GPS applications, Fundamentals of Mobile Mapping and its application.

**Practical** : Familiarization With GIS Software, Geo-referencing and Projection, Spatial Data Entry & Editing, Linking Spatial and Non Spatial Data, Query and Analysis, Vector Data Analysis, Network Analysis and Modeling, Output Map Generation, Exercise on Multi criteria Analysis, Field exercise on GPS data collection in stand-alone and Differential Mode, Field Exercise on Mobile mapping, Demo on Decision Support System.

**RSGIS-503 Digital Image Processing** **2+1** **Sem. II**

**Unit I** Concept of digital Image, Image Histogram, Color Composites-FCC Generation, Data and Image Storage Formats, Data Compression

**Unit II** Radiometric Compression, Image Rectification, Contrast Enhancement, Spatial and Frequency Domain Filtering

**Unit III** Spectral Indices, Image Transformations, Image Classification: Types, Image Classification: Unsupervised, Image Classification: Supervised

**Unit IV** Image Fusion, Change detection concepts and algorithms, Concept of feature extraction process. Data Processing techniques, Spectral Similarity Analysis

**Unit V** End member analysis, Information extraction from Hyperspectral Imagery, Digital Processing of Microwave data, LiDar data visualization and processing

**Practical** : Familiarization with DIP and Software's, Importing Raw Data and Subsets, displaying image data, Identification of objects, Image rectification and registration, Spectral Indices, Principal Component Analysis, Ground truth collection and field exercise, Unsupervised Classification, Supervised Classification, Image data fusion, Change detection analysis, Processing of hyperspectral data Neural network, Fuzzy logic, Processing of microwave data.

**RSGIS-504 Introduction to Photogrammetry and Cartography 2+1 Sem. I**

**Unit I** Optics, Photogrammetry, Aerial Cameras, Types of Photographs, Geometry of aerial photographs, Scale of aerial photographs, Tilt, Relief, Displacement

**Unit II** Stereovision and stereoscopes, Concept of parallax, Rotation matrix, Concept of omega. Phi and kappa, Aerial triangulation, Theory of orientation, Co linearity and co planarity, Transformation matrices

**Unit III** Stereo coverage from satellite sensor, Automatic DEM generation, Polynomial rectification, RFM/RFC, Grid sampling criteria, Grid re sampling methods, DTM derivatives, Differential rectification ortho image

**Unit IV** Image map generation, Type of maps-topographic & Thematic maps, Cartographic representation of geographic objects, Map projection, Map projection types

**Unit V** Digital mapping/Digital Cartography, Integration with geo spatial database, Grid sampling criteria, Grid re-sampling methods

**Practical :** Base map preparation from topographical sheet, Orientation of stereo model, Tracing of details in stereo pair, Use of parallax bar, Determination of height from stereo pair, Map projection conversion, DEM interpolation, DEM derivative extraction, Field exercise.

**RSGIS-505 Agri-Informatics 2+1 Sem. II**

**Unit I** Overview and importance, Need for Agri-informatics, Spectral characteristics of crops, Spectral Vegetation Indices

**Unit II** Crop discrimination and acreage estimation, Crop yield modeling and condition assessment, Significance of temporal satellite data, Cropping System analysis

**Unit III** Imaging spectroscopy, Optimum narrow bands and physiological narrow band indices, Red edge & their indices for crop stress assessment, Precision agriculture, prospects and scope in Indian agriculture, Crop parameter retrieval, Key biometric parameters

**Unit IV** Crop discrimination, Crop growth monitoring and assessment, Crop parameters retrieval from microwave data, Relational Agri-database information storage and retrieval

**Unit V** Productivity Constraints Analysis, Yield gap analysis, Early warning system, Decision Support System (DSS) in agriculture

**Practical** : Spectral reflectance of crops, Digital analysis, Crop discrimination and area estimation, Cropping pattern & cropping indices analysis, Spectral vegetation index based yield model, Crop condition assessment, Crop stress assessment using hyper-spectral satellite data, SAR data analysis for crop discrimination, Area estimation using SAR data, Ground truth data collection, SDSS for crop input optimization.

**RSGIS-506 Application of RS and GIS for Soil Resources Management 2+1 Sem. I**

**Unit I** Physiographic analysis and their relationship with soils, Soil mapping using aerial and satellite remote sensing data

**Unit II** Kinds of soil survey, basic concept of soil profile, spectra characteristics of soils, land capability classification, land evaluation for optimal land use planning

**Unit III** Identification, and mapping of wastelands and degraded lands, mapping of soil salinity and water logging, soil moisture estimation

**Unit IV** Concept of watershed and watershed management, types of drainage and their delineation, soil erosion and erosion hazard assessment, soil conservation and management

**Unit V** Soil Information System and soil coding.

**Practical** : Study and mapping of physiography using RS data, relationship between physiography and soil types, soil mapping using aerial and satellite data, identification and delineation of soil salinity and water logging, sand dunes, gullied and ravenous lands, soil erosion mapping, soil-site suitability evaluation, study of drainage and their characteristics, delineation of watersheds, soil coding and soil information system in GIS.

**RSGIS-507 Application of RS and GIS for Water Resources Management 2+1 Sem. I**

**Unit I** Development of scientific hydrology, importance of water, occurrence of water, hydrological cycle, Overview of remote sensing and GIS applications in hydrology.

**Unit II** Soil moisture at local and global scale, soil moisture retrieval using satellite data. Potential evapotranspiration and factors controlling it, Groundwater, originand occurrence, storage, types of aquifers, groundwater movement, level mapping.

**Unit III** Water pollution, and use of remote sensing in water quality studies. Evaluation of surface water resources and groundwater, water supplies and utilization, problems, policies and management.

**Unit IV** GIS for surface water modeling- groundwater modeling. Concept of irrigation command area development. Hydrologic Information System.

**Practical** : Basin/catchment/watershed delineation, Statistical and spatial analysis of precipitation data, Surface water body mapping and water quality analysis, Estimation of surface runoff using SCS method, Estimation of climatic water balance components, Rainfall retrieval using satellite data, Irrigation command area mapping using multi-temporal satellite data, Performance evaluation of irrigation command area, Ground water targeting, Ground water modeling.

**RSGIS-508 Application of RS and GIS for Land Resources Management 2+1 Sem. I**

**Unit I** Need for land resource development and planning. Land use/landcover classification schemes Utility of remote sensing data for land resource management. High resolution images, various vegetation indices. Levels & Scales of mapping.Visual and digital image interpretation techniques. Classification accuracy

**Unit II** Assessment Technologies for Large Scale Mapping (LSM) of urban areas.Total Station Differential Global Positioning System (DGPS).Issues in Large Scale Mapping.Selecting appropriate technologies and methodologies.

**Unit III** Concept and history of cadastral survey, Cadastral survey methods and survey maintenance, cadastral map reproduction, development of cadastral information system.

**Unit IV** Governance of urban regions: mapping administrative boundaries, city base map generation, property enumeration and property GIS, tax revenue rationalization

**Practical**: Land Use/Land Cover Mapping-Visual and digital analysis of satellite data. Mapping accuracy assessment. LU/LC temporal change analysis. Land Evaluation: Land irrigability classification, Land capability classification, Productivity indices and FAO method. Field work for ground truth data collections.

**RSGIS-591 Seminar 1+0**

**RSGIS-599 Master's Research 0+30**

# CIVIL ENGINEERING

## PROGRAMMES

**M.Tech.**

**Ph. D.**

## COURSE REQUIREMENTS

**M.Tech.**

| | |
|---|---|
| Field of Specialization | Hydrology and Water Resources Engineering, Structural Engineering |
| Required Courses | CE-502, CE-506 and CE-507 for Hydrology and Water Resources Engineering<br>CE-501, CE-503 and CE-504 for Structural Engineering |
| Supporting Courses | Stat.-502, or courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem. |
| Minor Field | Soil and Water Engineering, Computer Science and Engineering, Mathematics, Statistics, Mechanical Engineering, Renewable Energy Engineering or any other as approved by Dean Postgraduate Studies. |
| Common Courses | PGS-501, PGS-502, PGS 503, PGS 504, PGS-505 |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

**Ph.D.**

| | |
|---|---|
| Field of Specialization | Structural Engineering |
| Required Courses | CE-601,CE-602 |
| Supporting Courses | Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem. |
| Minor Field | Soil and Water Engineering, Computer Science and Engineering, Mathematics, Statistics, Mechanical Engineering, Renewable Energy Engineering or any other as approved by Dean Postgraduate Studies. |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**CE 105 Soil Mechanics** **2+1** **Sem. I**

Introduction of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, total stress, simple numerical problems related to stresses, Seepage Analysis, Quick condition, numerical problems related to Quick sand condition, Permeability, Factors affecting permeability, Numerical problems related to permeability, Constant Head and Variable head permeability test. Flow parallel and perpendicular to planes of stratification. Shear strength, Mohr stress circle, theoretical relationship between principle stresses and shear stresses, Mohr-coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, Unconfined compressive strength test, tri-axial test and vane shear test. Numerical exercise based on various types of tests. Compaction of soils, standard and modified proctor test, Jodhpur mini compaction test, field compaction method and control.Numerical problems related to Compaction. Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory, Laboratory consolidation test, determination of coefficient of consolidation by calculation of void ratio and coefficient of volume change.Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises. Introduction to bearing capacity and stability analysis.

**Practical**: Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Grain size analysis by hydrometer method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Determination of liquid limit by Casagrande's method, cone penetrometer; Determination of plastic limit; Determination of shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Tri-axial test; Determination of consolidation properties of soils.

**CE 106 Surveying and Leveling** **1+2** **Sem. II**

Surveying: Introduction, classification and basic principles. Linear measurements. Chain surveying. Cross staff survey. Compass survey. Planimeter. Errors in measurement, their elimination and correction.Plane table surveying. Levelling, levelling difficulties and error in levelling. Contouring.Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Total station, Electronic theodolite. Introduction to GPS survey.

**Practical**: Chain survey of an area and preparation of map. Compass survey of an area and plotting of compass survey. Plane table surveying. Levelling. L section and X sections and its plotting. Contour survey of an area and preparation of contour map. Introduction of software in drawing contour.Theodolite surveying. Ranging by theodolite, height of object by using theodolite. Setting out curves by theodolite. Minor instruments.Use of total station.

**CE 108 Engineering Mechanics** **2+1** **Sem. II**

Basic concepts of Engineering Mechanics.Force systems, composition and resolution of forces, moment of a force, couple and its transmission, resolution of a force into a force and a couple. Centroid, Moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas, Equilibrium of concurrent co-planer and non-concurrent co-planer force systems. Free body diagram and equilibrium of forces. Frictional forces. Analysis of simple framed structures using method of joints, method of sections and graphical method. Simple stresses. Shear force and bending moment diagrams for various combinations of loads and beams. Stresses in beams.Torsion.Analysis of plane and complex stresses.

**Practical**: Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple. Problems relating to resultant of Co-planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non-concurrent force system, Non-coplaner concurrent force system, Non-coplaner non-concurrent force system, system of couples in space. Problems relating to centroids of composite areas.Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas. Equilibrium of concurrent co-planer and non concurrent co-planer force system. Problems involving frictional forces.Analysis of simple trusses by method of joints and method of sections.Analysis of simple trusses by graphical method.Problems relating to simple stresses and strains.Problems on shear force and bending moment diagrams. Problems relating to stresses in beams.Problems on torsion of shafts. Analysis of plane and complex stresses.

**CE 207 Watershed Hydrology** **1+1** **Sem. I**

Hydrologic cycle. Precipitation, forms and measurement. Precipitation analysis. Estimation of missing data.Interception, infiltration, evaporation, their estimation and measurement, factors affecting Infiltration indices. Runoff: factors affecting, measurement, estimation of peak runoff rate and volume, rational method, Cook's method and SCS curve number method. Geomorphology of watersheds. Hydrograph: components, base flow separation, unit hydrograph theory, S curve. Synthetic hydrograph. Stream gauging: stage discharge rating curves, flood peak, design flood and computation of probable flood. Flood routing: channel and reservoir routing. Drought: classification, causes, impact and management.

**Practical**: Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity duration frequency curve.Exercise on depth area duration and double mass curve. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall record. Exercise on computation of infiltration indices. Computation of peak runoff and runoff volume by Cook's method and rational formula. Computation of runoff volume by SCS curve number method. Study of stream gauging instruments: current meter and stage level recorder. Exercise on geomorphic parameters of watershed. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.

**CE 208 Strength of Materials** **2+1** **Sem. I**

Slope and deflection of beams using integration technique, moment area theorem and conjugate beam method.Columns and struts.Concept of effective length of column, analysis of axially loaded columns using Euler's method and Rankine's method for different end conditions.Stability analysis of masonry dams.Introduction to indeterminate beams.Analysis of statically indeterminate beams: propped beams, fixed and continuous beams using method of superposition, three moment equation and moment distribution method.

**Practical**: To perform the tension test on metal specimen (mild steel, cast iron), to observe the behavior of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation and to study their fracture. To perform the compression test on concrete cylinders, cubes, mild steel, cast iron, wood specimen and to determine various physical and mechanical properties. To perform the bending test on the specimens: mild steel girder, wooden beam, plain concrete beams, reinforced cement concrete beam and to determine the various physical and mechanical properties. To determine Young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre and quarter points. To study the behaviour of materials (galvanised iron, mild steel, cast iron pipes) under torsion and to evaluate various elastic constants. To study load deflection and other physical properties of closely coiled helical spring in tension and compression. To perform the Rockwell, Vicker's and Brinell's Hardness tests on the given specimens.To perform the Drop Hammer Test, Izod Test and Charpy's impact test on the given specimens. To determine compressive and tensile strength of cement after making cubes and briquettes.To measure workability of concrete (slump test, compaction factor test).To determine void ratio and bulk density of cement, fine aggregates and coarse aggregates. To determine fatigue strength of a given specimen.To write detailed report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

**CE 306 Building Construction and Cost Estimation** **2+0 Sem. I**

Building materials: rocks, stones, bricks, tiles, lime, cement, aggregates, concrete, glass, rubber, plastics, iron, steel, aluminum, copper, nickel and timber.Building components: walls, columns, beams, arches, lintels, slabs, staircases and floors.Different types of floors: brick floor, timber floor, reinforced cement concrete floor, terrazzo floor, marble floor. Finishing: damp proofing and water proofing, plastering, pointing, painting, whitewashing and distempering.Brick masonry and stone masonry.Different types of Brick Bond: English Bond, Single Flemish Bond, Double Flemish Bond. Procedure for design of a building.Types of agricultural buildings.Sloped and flat roof buildings and their construction economics. Preliminary estimates, detailed estimates of buildings, source of cost information, cost analysis, factors affecting building costs, cost evaluation of building and planning for state development.Measurement and measurement book.Economic methods for evaluating investment in buildings and building systems: cost in use, benefit to cost and savings to investment ratios, rate of return, net benefits, payback period.

**CE 307 Design of Structures** **2+1 Sem. II**

Introduction to various types of loads: dead load, wind load, live load and earthquake load. Use of Bureau of Indian Standard codes.Introduction to design philosophies.Design of riveted, welded and bolted connections. Design of structural steel members in tension, compression and bending.Introduction to trusses, analysis of truss for dead load, live load and wind load. Design of truss elements. Introduction to reinforced cement concrete.Balanced, under reinforced and over reinforced sections.Design of singly and doubly reinforced sections.Shear, Bond and Torsion. Design of flanged beams.Design of one way and two way slabs. Design of axially loaded columns.Design of wall footing, isolated footing and combined footing.Introduction to cantilever and counter fort retaining walls.Design of cantilever retaining wall.Introduction to silos and theories related to their analysis.

**Practical**: Design and drawing of steel roof truss. Design and drawing of singly reinforced beam, doubly reinforced beam. Design and drawing of one way and two way slabs. Design and drawing of RCC building. Design and drawing of retaining wall.

## Postgraduate Courses

**CE-501 Dimensional Analysis and Similitude** **2+0 Sem. I**

**Unit I** Introduction, dimensions, dimensional homogeneity, non-dimensional parameter, methods of dimensional analysis: Rayleigh's method, Buckingham-pi theorem, choice of variables, model analysis, examples on various applications, dimensional analysis and intermediate asymptotic.

**Unit II** Model studies, model classification, dimensionless numbers: Reynolds model, Froude's model, Euler's model, Webber's model, Mach model, scale effects, distorted models, model laws.

**Unit III** Similitude: types of similarities (geometric-kinematic and dynamic similarity), force ratios, similarity laws. Model analysis: physical models. Similarity methods for nonlinear problem types of models, scale effect. Numerical problems on Reynolds's and Froude's model.

**Unit IV** Use and scope of mathematical modeling, principles of model formulation, role and importance of steady-state and dynamic simulation, classification of models, model building, modeling difficulties, degree-of-freedom analysis, selection of design variables.

**CE-502 Water Quality and Pollution Control** **2+1 Sem. II**

**Unit I** Physical and chemical properties of water, suspended and dissolved solids, EC and pH, major ions. Water quality (Physical, Chemical and Bacteriological) investigation, Sampling design, Samplers and automatic samplers.Data collection platforms, Field kits, Water quality data storage, analysis and inference, Software packages.Water quality indices.Water quality for irrigation.Salinity and permeability problem, saline water irrigation root zone salinity, interaction of irrigation and drainage.

**Unit II** Sources and types of pollution, organic and inorganic pollutants.BOD–DO relationships, impacts on water resources.NPS pollution and its control, Eutrophication control.Water treatment technologies, Constructed wetlands.

**Unit III** Multiple uses of water.Reuse of water in agriculture. Low cost wastewater treatment technologies Economic and social dimensions.Packaged treatment units, soil-based water treatment methods, reverse osmosis and desalination in water reclamation.

**Unit IV** Principles of water quality, water quality classification, water quality standards, water quality indices, TMDL Concepts.Water quality models.Soil crop and other practices for use of poor quality water.

**Practical** : Determination of pH, total solids, dissolved and suspended solids, chlorides, sulphates, turbidity, dissolved oxygen, hardness. Preparation of water quality map of watershed in GIS environment. Visit of water polluted site of nearby area.

**CE-503 Earthquake Resistant Design of Structures** **3+0** **Sem. I**

**Unit I** Elements of earthquake Engineering: Behaviour of buildings and structures during past earthquakes and lessons learnt, Earthquake magnitude and intensity, Focus and Epicentre, causes and effects of earthquakes, characteristics of earthquake, seismic zone mapping.

**Unit II** Analysis for earth quake loads: Earthquake design philosophy, assumptions, analysis by seismic coefficient and response spectrum methods, displacements and drift requirements, time history method. Provisions for torsion, applications to multi-storied building frames – water tanks. Analysis and behaviour of masonry infilled RC frames, earthquake resistant measures in masonry buildings.

**Unit III** Earthquake Resistant Design: Code based seismic design methods, equivalent lateral force method, response spectrum method, time history method, soil dynamics, spectral analysis, nonlinear and push over analysis, effect of plan configurations on the response of the structure.

**Unit IV** Storage Silos and tanks, Base Isolation: Introduction to IS Code 1893 Part-2 (2014), elevated liquid storage tanks, hydrodynamic pressure in tanks, retrofitting and base isolation technique, retrofitting and strengthening of structures, base isolation concept, isolation systems and their modeling, linear theory of base isolation, stability of elastomeric bearings, codal provisions for seismic isolation, introduction to different types of seismic dampers.

**CE-504 Advanced Construction Practices and Steel Detailing** **2+1** **Sem. II**

**Unit I** Concrete construction methods, formwork design and scaffolding, slip forms and other moving forms, pumping of concrete, grouting and mass concreting operations, roller compacted concrete, ready-mix concrete

**Unit II** Various methods of handling and placing concrete, accelerated curing, hot and cold weather concreting, under water concreting, creep of concrete, permeability and durability of concrete, computer aided concrete mix design, fibre reinforced concrete, high performance concrete

**Unit III** Cladding panels, steel and composite construction methods, fabrication and erection of structures including heavy structures, prefab construction, industrialised construction and modular coordination.

**Unit IV** Special construction methods, construction in marine environments, high rise construction, bridge construction including segmental construction, incremental construction and push launching techniques, geo synthetics, safety, quality measures and reliability.

**Practical :** Drawing and detailing of steel rebars in R.C.C beams, slabs, columns, walls and foundation.

**CE-505 Repair and Retrofitting of Structures** **3+0** **Sem. I**

**Unit I** Principles of retrofitting, objective and principles of intervention, design steps for intervention, criteria for repair and retrofitting

**Unit II** Investigation and diagnosis of defects, causes of defects, repair materials and techniques, repairs to cracked concrete: purpose of repair and classifications, spalled concrete, hand-applied repairs, surface preparation for repairs, sprayed concrete

**Unit III** Dry and wet processes.Underwater repairs, patch repair, repair of concrete floors, seismic vulnerability evaluation of buildings, feasibility assessment, design considerations, techniques of retrofitting and improving structural integrity of masonry buildings.

**Unit IV** Codes of practices for repair and retrofitting, techniques of retrofitting of RC buildings and structural elements, retrofitting of bridges and dams and heritage structures, retrofitting of structures by seismic base isolation, case studies of retrofitting of structures.

**CE-506 Dams and Reservoir Operations** **2+1** **Sem. II**

**Unit I** Dams classification.Suitable site selection for dams and reservoirs.Survey and planning of storage projects.Types of concrete dams.Forces acting on concrete dams.

**Unit II** Stability analysis.Methods of design of gravity dams.Concrete cooling and temperature control for dams.

**Unit III** Earth dams and their types.Methods of construction.Causes of failure and remedial measure. Seepage and stability analysis of earth dams.Foundation treatment and Abutment grouting.

**Unit IV** Instrumentation in dams.Spillway and spillway capacities.Spillway Gates.Reservoir planning. Storage, sedimentation and losses.Reservoir economics.Flood routing.

**Practical** : Design and analysis of earth and gravity dams. Seepage analysis.Stability analysis of earth dams. Reservoir design.

**CE-507 Open Channel Flow** **3+0** **Sem. I**

**Unit I** Open channel and their properties. Energy and momentum principles.Critical flow computations and applications.

**Unit II** Uniform flow.Its development .Formula and design computation.Boundary layer concept. Surface roughness.

**Unit III** Velocity distribution and instability of uniform flow.Gradually varied flow theory and analysis. Method of computations.

**Unit IV** Hydraulic jump and its use as energy dissipater.Spatially varied flow.Unsteady flow. Rapidly varied flow.

**CE-508 Agro Industrial Pollution Control** **3+0** **Sem. I**

**Unit I** Introduction to agro industrial wastewater. Relevant standards for wastewater.

**Unit II** Characteristics of agro industrial liquid wastes from cannery, brewery, distillery, dairy, meatpacking, sugar, fertilizers and pesticides industries.

**Unit III** Quantity of wastewater from different industries and monitoring of its quality.Treatment processes.

**Unit IV** Design to control pollution of environment. Disposal standards and disposal of waste water.

**CE-509 Control of Pollution from Solid Waste** **2+0** **Sem. I**

**Unit I** Introduction.Terminology in pollution control Sources Classification, quantities and characteristics of solid wastes.

**Unit II** Collection.Transport and reduction at source.Disposal methods-open dumping, site selection, ocean disposal.Feeding to nog Merits and demerits.

**Unit III** Treatment methods-methods of refuse processing. Fertilizer. Fuel and food values.

**Unit IV** Sanitary landfill, composting, incineration and pyrolysis. Recycle and reuse- Materials and energy recovery operations.

**CE-510 Experimental Stress Analysis** **3+0** **Sem. II**

**Unit I** Stress and Strain relationship.Generalized Hook's Law, Strain Gauges- Mechanical, optical, electrical, acoustical and pneumatic etc and their use.

**Unit II** Different types of electrical resistance strain gauges, Semi-conductor strain gauges. Rosette analysis.Strain gauge circuits.Strain measurements at high temperatures.

**Unit III** Two dimensional and three dimensional photo-elastic method of strain analysis. Birefringent coatings and scattered light in photo-elasticity.

**Unit IV** Brittle coating methods.Moire's method of strain analysis. Grid method of strain analysis. Photo elastic strain gauges.

**CE-511 Landfills and Ash ponds** **3+0** **Sem. II**

**Unit I** Integrated solid waste management of municipal solid waste, hazardous waste, coal ash and other wastes; Landfilling practice for different types of solid wastes;

**Unit II** Municipal solid waste landfills: acceptability of waste; planning, design, construction, operation and closure including management of leachate and gas.

**Unit III** Hazardous waste landfills: waste compatibility and acceptability; planning, design, construction, operation, closure and environmental monitoring.

**Unit IV** Ash ponds: Slurry disposal versus dry disposal; Engineering properties of bottom ash, fly ash and pond ash; planning and design; incremental raising of height by upstream and downstream methods; closure and reclamation.

**CE-512 Mechanics of Sediment Transport** **3+0** **Sem. I**

**Unit I** Fluvial sediments; transportation and entrainment; physical & chemical characteristics; grain size distribution; Physical properties of fluid and sediment, origin and properties of sediments, nature of problems.

**Unit II** Scour criteria and problems: regimes of flow, Shields curve, incipient motion of sediment particles, terminal fall velocity of sediment in fluid, alluvial bed forms and Resistance to flow.Bed load, suspended load and total load transport, Meyer-Peter approach, du Boys' approach, Einstein's approach, Engelund and Fredsøe's approach, sediment samplers, design of stable channels, alluvial stream and their hydraulic geometry.

**Unit III** Decomposition and averaging procedure, equation of motion (Reynolds equations), Prandtl's mixing length theory, hypothesis of von Kármán, velocity distribution, the linear law in viscous sub-layer, the logarithmic law in turbulent wall shear layer, law in buffer layer, log-wake law and velocity defect law, turbulence intensity, calculation of bed shear stress using bed slope, velocity distribution, average velocity, Reynolds shear stress distribution, turbulent kinetic energy distribution.

**Unit IV** Objectives, classification of river training works, design of guide banks, groynes or spurs their design and classification ISI Recommendations of approach embankments and afflux embankments, pitched islands, artificial cut-offs, objects and design considerations, river control-objectives and methods.

**CE-513 Geotechnical Investigations and Ground Improvement** **3+0** **Sem. II**

**Unit I** Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record.

**Unit II** Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions.Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties. Report writing. Safety measures.

**Unit III** Geotechnical Processes: Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control.

**Unit IV** Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen. Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electroosmosis, lime column. Soil-lime column. Grouting :permeation, compaction and jet. Vibro-floatation, dynamic compaction, thermal, freezing. Dewatering systems.

**CE-514 Environmental System Analysis** **2+0 Sem. I**

**Unit I** Introduction to natural and man-made systems.Systems modeling as applied to environmental systems. Nature of environmental systems, the model building process addressing to specific environmental problems.

**Unit II** Strategies for analyzing and using environmental systems models.Fate and transport models for contaminants in air, water, and soil.

**Unit III** Optimization methods (search techniques, linear programming, non-linear programming, dynamic programming) to evaluate alternatives for solid-waste management and water and air pollution control.

**Unit IV** Optimization over time.Integrated environmental management strategies addressing multi-objective and multi-stakeholder planning.

**CE-515 Solid and Hazardous Waste Management** **3+0 Sem. II**

**Unit I** Municipal Solid Waste: Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste

**Unit II** Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling.Transport of Municipal Solid Waste, Routing and Scheduling, Treatment.

**Unit III** Transformations and Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling).

**Unit IV** Norms, Rules and Regulations.Economics of the on-site v/s off site waste management options. Integrated waste management.

**CE-516 Construction Management and Equipment** **3+0 Sem. II**

**Unit I** Principle of Engineering Economy, minimum cost point analysis, break-even point analysis, depreciation and depletion.

**Unit II** Safety in construction: causes, classification, cost and measurement of an accident, safety programme for construction, protective equipment, accident report, safety measure for storage and handling of building materials, construction of elements of a building and in demolition of buildings.

**Unit III** Need of construction planning, Constructional Resources, construction team, stages in construction, preparation of construction schedule, Job layout, inspection and quality control, Introduction and characteristics of management, Principle and function of management, Scientific And Materials Management: Scope, objective and functions of material management, procurement and store management, materials handling management, inventory control and management, disposal of surplus materials,

**Unit IV** Earth Moving Equipments: Crawler and wheel tractors their functions, types and specifications, gradability, bull dozers and their use, tractor pulled scrapers, their sizes and output, effect of grade an rolling resistance on the output of tractor pulled scrapers, earth loaders, placing and compacting earth fills, power shovels- functions, selection, sizes, shovel dimension and clearances, output, drag lines functions, types sizes, output clamshells, safe lifting capacity and working range cranes, hoes, trenching machine, types and production rate calculations, producting rates of equipment.

**Unit V** Hauling & Piling Equipment: Trucks, Bottom dump wagons, capacities of trucks and wagons Balancing the capacities of hauling units with the size excavator, effect of grade, rolling resistance and altitude on the cost/performance of hauling equipment, Pile hammers, selecting a pile hammer, loss of energy due to impact, Energy losses due to causes other than impact.

**CE-517 Concrete Technology and Pre-stressed Concrete** **3+0 Sem. I**

**Unit I** Concrete mix design. Rheological, physical and mechanical properties of concrete.Permeability, Curing, Volume change, creep, Gunite and shotcrete, Ferro-cement.

**Unit II** Basic Principles of prestressing, types of prestressing, systems of prestressing, loss of prestress, materials used, advantages and disadvantages. Critical load condition, permissible stresses,

various methods of design, design procedure based on flexure, minimum weight design, cable layout and profile of tendons, design by load balancing method, code provisions.

**Unit III** Allowable stress considerations, non-dimensional allowable stress equations and their solution, shrinkage stresses. Two span continuous beams and their analysis, application of moment distribution method, design of continuous beams, continuous beams with variable section.

**Unit IV** Beam and slab construction, principal stresses, failure due to shear, combined bending and shear, bond, pre-stressing cable at the centroidal axis, symmetric multiple cable, spalling and bursting stresses.

**CE-518 Advanced Foundation Design** **3+0** **Sem. II**

**Unit I** Subsurface Exploration: boring, sampling, SPT, CPT, Geophysical methods, Bore log and soil report. Shallow Foundations: Terzaghi's, Meyerhoff, Hansens bearing capacity theories based on SPT, layered soils, eccentric and inclined loads. Bearing capacity on slopes, Foundation settlements.

**Unit II** Design of Combined and Raft Foundations: Design of footings by conventional and elastic line methods. Design of retaining walls and sheet pile walls: lateral earth pressure, retaining wall stability. Cantilever and anchored sheet pile walls.

**Unit III** Pile Foundations: Load transfer mechanism, Pile capacity in various soil types, negative skin friction, group action, settlements, laterally loaded vertical piles.

**Unit IV** Drilled piers and caissons, reinforced earth: design considerations, bearing capacity equations, settlements, lateral loads, types of caissons, stability analysis, materials and general considerations, design and stability.

**CE-519 Advanced Solid Mechanics** **3+0** **Sem. I**

**Unit I** Introduction to elasticity, displacement, strain and stress fields, constitutive relations, cartesian tensors and equations of elasticity, elementary concept of strain, stain at a point, principal strains and principal axes, compatibility conditions, stress at a point, stress components on an arbitrary plane, differential equations of equilibrium, hydrostatic and deviatoric components.

**Unit II** Equations of equilibrium, stress- strain relations, strain displacement and compatibility relations, boundary value problems, co-axiality of the principal directions.

**Unit III** Two-dimensional problems of elasticity, plane stress and plane strain problems,Airy's stress function, two-dimensional problems in polar coordinates, torsion of prismatic bars, Saint Venant's method, Prandtl's membrane analogy, torsion of rectangular bar, torsion of thin tubes.

**Unit IV** Plastic Deformation, Strain Hardening, Idealized Stress- Strain curve, Yield Criteria, von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations, Principle of Normality and Plastic Potential, Isotropic Hardening.

**CE-520 Design of R. C. C. Bridges** **2+1** **Sem. II**

**Unit I** Use of Codes.Investigation for bridges, General design considerations.Indian Standards specifications for road & railway bridges, loads and stresses.

**Unit II** Design of foot bridge, Slab bridge, T-beam bridge and balanced cantilever bridges.

**Unit III** Design of piers and bearings.

**Unit IV** Design of piles and well foundations.

**Practical:** Design problems of foot bridge, slab bridge, T-beam bridge, balanced cantilever bridge, piers, bearings, piles and well foundations.

**CE-521 Inelastic Design in Structures** **3+0** **Sem. I**

**Unit I** Principles of Limit State design, Flexural strength of R.C.C. Structures.

**Unit II** Strength of R.C.C. Sections in shear, torsion and bond. Limit state of serviceability.

**Unit III** Inelastic design of reinforced concrete beams and columns.Analysis of continuous beams and frames.

**Unit IV** Design of steel members in tension, compression and bending.Design of aluminium members. Plastic analysis. Design of indeterminate beams and frames.

**CE-522 Advanced Structural Analysis** **3+0** **Sem. II**

**Unit I** Influence Coefficients: Physical significance, effects of settlements, temperature change and lack of fit, member approach and structure approach.

**Unit II** Stiffness Method applied to Large Frames: Local coordinates and global coordinates. Stiffness matrix assembly of structures: stiffness matrix in global coordinates, boundary conditions, solution of stiffness matrix equations, calculation of reactions and member forces.

**Unit III** Applications to Simple Problems: Beams, plane trusses, plane rigid jointed frames and grids by structure approach and member approach. Approximate solution of boundary value problems, modified galerkin method for one-dimensional bvp, matrix formulation of the modified galerkin method.

**Unit IV** Linear Element: Shape functions, solution for poisson's equation, general one dimensional equilibrium problem.

**CE-591 Seminar** **1+0**

**CE-599 Master's Research** **0+30**

## Ph.D. courses

**CE-601 Advanced Reinforced Concrete Design** **3+0** **Sem. I**

**Unit I** Deflection of Reinforced Concrete Beams and Slabs: Introduction, short-term deflection of beams and slabs, deflection due to imposed loads, short-term deflection of beams due to applied loads, calculation of deflection by IS 456. Estimation of crack-width in reinforced concrete members: Introduction, factors affecting crack-width in beams, mechanism of flexural cracking, calculation of crack-widths, simple empirical method, estimation of crack-width in beams by IS 456.

**Unit II** Design of reinforced concrete deep beams: Introduction, parameters influencing design, flexural bending and shear stresses in deep beams, minimum thickness, steps of designing deep beams, design by IS 456, checking for local failures, detailing of reinforcement in deep beams.

**Unit III** Design of slender columns: Concentrically loaded slender columns, eccentrically loaded slender columns, slender columns subjected to axial and transverse loads, structural behavior of columns in braced and unbraced frames, codal procedure for design of slender columns.

**Unit IV** Design of Flat Slabs: Proportioning of flat slabs, determination of bending moment and shear forces, direct design method and equivalent frame method. Yield line analysis of slabs: Characteristic features of yield line, yield line patterns, moment capacity along yield line, ultimate load on slabs, virtual work and equilibrium methods of analysis for square and circular slabs with simple and continuous end conditions.

**CE-602 Dynamic Response of Structures** **3+0** **Sem. II**

**Unit I** Theory of vibrations: Introduction, elements of vibratory system, degrees of freedom, idealization of structures, continuous system, Lumped mass idealization, oscillatory motion, Simple Harmonic motion, vectorial representation of S.H.M., free and forced vibrations of single degree of freedom system, free and forced vibrations of damped and undamped structures, critical damping, logarithmic decrement, Harmonic excitation, dynamic magnification factor, bandwidth.

**Unit II** Fundamental objectives of dynamic analysis, types of prescribed loading, methods of discretization, formulation of equations of motion by different methods, direct equilibration using Newton's law of motion, D'Alembert's principle, Principle of virtual work and Hamilton principle. Single Degree of Freedom Systems: Mass spring damper system, formulation and solution of the equation of motion, analysis of free vibrations, response to harmonic loading, periodic loading, Impulsive loading and general dynamic loading, generalized SDOF, vibration analysis by Rayleigh method.

**Unit III** Multi Degree of Freedom Systems: Selection of the degrees of freedom, evaluation of structural property matrices, formulation of the MDOF equations of motion, undamped free vibrations, solutions of Eigen value problem for natural frequencies and mode shapes, analysis of dynamic response, normal co-ordinates, uncoupled equations of motion, orthogonal properties of normal modes, mode superposition procedure.

**Practical** Vibration Analysis: Introduction, Stodola method, fundamental mode analysis, analysis of second and higher modes, Holzer method, Basic procedure.

**CE-603 Finite Element Applications in Structural Engineering 3+0 Sem. I**

**Unit I** Introduction**,** concepts of FEM, steps involved, merits and demerits, energy principles, discretization methods, Rayleigh –Ritz method of functional approximation. Principles of Elasticity:Basic equations in elasticity, stress equations, strain displacement relationships in matrix form, plane stress, plane strain and Axi-symmetric bodies of revolution with Axi-symmetric loading.

**Unit II** One-dimensional FEM: Stiffness matrix for beam and bar elements, shape functions for one-dimensional elements. Two dimensional FEM: Different types of elements for plane stress and plane strain analysis, displacement models, generalized coordinates, shape functions, convergent and compatibility requirements, geometric invariance, natural coordinate system, area and volume coordinates, generation of element stiffness and nodal load matrices.

**Unit III** Iso-parametric formulation: Concept, coordinate transformation, basic theorems of iso-parametric concept, different iso-parametric elements for 2D analysis, formulation of 4-noded and 8-nodediso-parametric quadrilateral elements, Lagrange elements, Serendipity elements, finding shape functions using Lagrange polynomials, shape functions for Serendipity family elements, Hermite polynomials as shape functions, construction of shape functions by Degrading technique.Axi-symmetric analysis: Bodies of revolution, axi-symmetric modeling, strain displacement relationship, formulation of axi-symmetric elements.

**Unit IV** Introduction to Finite Element Analysis of Plates: Basic theory of plate bending, thin plate theory, stress resultants, Mindlin's approximations, formulation of 4-noded isoperimetric quadrilateral plate element, shell element.

**CE-604 Design of Tall Structures 3+0 Sem. II**

**Unit I** Basic introduction and importance of tall structures, dead load, live load, impact load, construction load, sequential loading. Wind Loading: Static and dynamic approach, analytical and wind tunnel experimental methods. Earthquake Loading: Equivalent lateral load analysis, Response spectrum method, combination of loads.

**Unit II** Analysis and Design of Tall Buildings: Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of structures as an integral unit, analysis for member forces.Analysis of tall buildings for lateral loads: Cantilever method, Portal method, Factor method. Design of structures for wind drift and twist.Computer applications in analysis and design.

**Unit III** Behavior of Structural Systems: Factors affecting the growth, height and structural form, behavior of braced frames, rigid frames, in-filled frames, shear walls, coupled shear walls, wall–frames, tubular and outrigger braced systems under wind loads.

**Unit IV** Stability of Tall Buildings: Overall buckling analysis of frames, wall-frames, approximate methods, second order effects of gravity loading, P-Delta effects, simultaneous first order and P-Delta analysis, transnational and torsional instability, out of plumb effects, effect of stiffness of members and foundation rotation in stability of structures.

**CE-605 Design of Industrial Structures 3+0 Sem. I**

**Unit I** Classification of industries and industrial structures, exploration of the site, elements of an industrial building, structural planning and layout of buildings and components, planning for layout requirements regarding lighting, ventilation and fire safety, protection against noise and vibration, guidelines from Factories Act.

**Unit II** Analysis of industrial building for gravity and wind loads, analysis and design of framing components namely girders, trusses and gable frames.Design of gantry girder with static and moving loads.

**Unit III** Transmission and Communication towers: Types and configuration, loads & load combinations be considered, analysis and design of tower & foundations. Chimneys: loads and stresses in chimney shaft, earthquake and wind effect, stresses due to temperature difference, combined effect of loads and temperature. Design of RC chimney.

**Unit IV** Bunkers & Silos: Introduction, Jassen's theory, Airy's theory, shallow and deep bins, design of RC circular/cylindrical bunkers, silos using Jensen's theory as per IS. Grid Slabs: Introduction, size of beams and topping, design of RC Grid slab using Rankine Grashoff method, detailing of reinforcement.

**CE-606 Optimization Techniques in Structural Engineering 3+0 Sem. II**

**Unit I** Introduction to optimization, engineering applications of optimization, classification of optimization problems, classical optimization techniques, single variable optimization, multivariable optimization with no constraints, multivariable optimization with equality constraints, multivariable optimization with inequality constraints.

**Unit II** Linear programming: Standard form of linear programming, geometry of linear programming problems, definitions and theorems, solution of a system of linear simultaneous equations, applications of linear programming, pivotal reduction of general system of equations. Simplex algorithm.Revised Simplex method.Duality in linear programming: Duality theorems, Dual simplex method, examples from real world.

**Unit III** Non-linear programming: Unrestricted Search, exhaustive search, dichotomous search, Interval halving method, Fibonacci method, Golden section method. Interpolation methods: Quadratic and cubic methods. Unconstrained optimization techniques: Direct search methods, random search methods, grid search method, univariate method. Indirect search (descent) methods: Steepest Descent (Cauchy) method, Newton's method, Quasi-Newton methods.

**Unit IV** Constrained optimization techniques: Direct methods, random search methods, complex method. Indirect methods, transformation techniques, interior and exterior penalty function methods, extrapolation techniques in interior penalty function method, extended interior penalty function methods, penalty function method for parametric constraints.

**CE-691 Seminar I 1+0**

**CE-692 Seminar II 1+0**

**CE-699 Ph.D Research 0+75**

# MECHANICAL ENGINEERING

## PROGRAMMES

**M.Tech.**

**Ph.D.**

## COURSE REQUIREMENTS

### M.Tech.

| | |
|---|---|
| Field of Specialization | Thermal Engineering, Machine Design |
| Required Courses | ME-505, ME-506 and ME-510 for Thermal Engineering ME- 507, ME-508 and ME-515 for Machine Design |
| Supporting Courses | Stat.-502, Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem can be taken as per recommendations of the student's advisory committee. |
| Minor Field | Computer Science and Engineering, Electrical Engineering, Civil Engineering, Processing and Food Engineering, Farm Machinery and Power Engineering, Renewable Energy Engineering or any other as approved by the Dean Postgraduate Studies |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Thermal Engineering |
| Required Courses | ME-601, ME-602 |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Minor Field | Processing and Food Engineering, Renewable Energy Engineering or any other as approved by the Dean Postgraduate Studies. |
| Deficiency Courses | As recommended by student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**ME 101 Workshop Technology** **1+2** **Sem. I**

**(For students of College of Agriculture)**

Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications; Safety measures in workshop; Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc.; Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipments; Gas welding and gas cutting, arc welding; Introduction to soldering and brazing and their uses; Smithying and forging: Introduction to different tools and their uses; Different forging operations, defects of forging; Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc.; Machinery: Introduction to various workshop machines (1) Lathe, (2) Milling machine, (3) Shaper and planner, (4) Drilling and boring machine, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, work holding and tool holding devices; Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

**Practical:** Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipments, tools and their use; Exercises on mould making using one piece pattern and two piece pattern; Demonstration of mould making using sweep pattern and match plate pattern; Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs.

**ME 102 Engineering Drawing and Graphics** **0+3** **Sem. II**

**(For students of College of Agriculture)**

Introduction of drawing scales; Principles of orthographic projections (First and third angle methods of projection); Different methods of dimensioning; References planes; Points and lines in space and traces of lines and planes; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Concept of sectioning; Section of solids; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings from models and isometric views of objects and machine components/food equipment; Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws. Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD. Demonstration on computer graphics and computer aided drafting use of standard software; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects on food equipment and components using CAD.

**ME 103 Engineering Drawing** **0+2** **Sem. I**

Introduction of drawing scales; First and third angle methods of projection. Principles of orthographic projections; Different methods of dimensioning; References planes; Points and lines in space and traces of lines and planes; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Concept of sectioning; Section of solids; Development of surfaces

of geometrical solids; Isometric projection of geometrical solids. Preparation of working drawing from models and isometric views. Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws.

**ME 104 Workshop Technology and Practice** **1+2** **Sem. II**

Introduction to welding, Oxyacetylene welding, types of flames, welding techniques and equipment. Arc welding and equipment. Casting processes. Lathe: Main accessories and attachments, operations and tools. Types of shapers, constructional details of standard shaper, work holding devices, tools and operations. Types of drilling machines. Constructional details of pillar type and radial drilling machines. Work holding and tool holding devices. Twist drills, drill angles and sizes. Types, constructional details and principles of operation of column and knee type universal milling machine. Plain milling cutter and operations.

**Practical:** Introduction to various carpentry tools, materials, types of wood and their characteristics and processes or operations in wood working. Preparation of simple joints: Cross half Lap joint and T-Halving joint, preparation of Dovetail joint, mortise and tenon joint. Introduction to smithy tools and operations. Jobs on bending, shaping, drawing, punching, riveting. Introduction to tools and measuring instruments for fitting, jobs on sawing, filing and right angle fitting of MS flat, practical in more complex fitting job. Operations of drilling, reaming and threading with tap and dies. Introduction to tools and operations in sheet metal work, making different types of sheet metal joints using G.I. sheets. Introduction to welding equipment, processes tools, their use and precautions. Jobs on arc welding: Lap, butt, T-Joint and corner joint in arc welding, Gas welding practice: Lap, butt and T-Joints. Introduction to metal casting equipment, tools and their use, mould making using one-piece pattern and two-piece pattern, demonstration of mould making using sweep pattern and match plate patterns. Introduction to machine shop machines and tools, demonstration on processes in machining and use of measuring instruments. Practical jobs on simple turning, step turning, taper turning, drilling and threading. Operations on shaper and planer, changing a round MS rod into square section on a shaper, demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing. Any additional job.

**ME 106 Food Thermodynamics** **2+1** **Sem. II**

**(For students of College of Agriculture)**

Basic concepts: Definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat. First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis. Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, thermodynamic temperature scale, entropy, availability and irreversibility. Properties of pure substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule. Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, Rankine Reheat cycle, air standard Otto cycle, air standard Diesel cycle, air standard Brayton cycle. Psychrometry: Thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying. Sorption isotherms, Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization. Measurement of humidity. Properties of steam: Wet, dry saturated, superheated steam. Use of steam tables.

**Practical:** Determination of dryness fraction of steam. Vapor-compression refrigeration cycle. Determination of state of air using psychometric chart and hygrometer. Use of psychrometric chart during drying process/humidification process. Demonstration of equilibrium sorption isotherms. Visit to food plant with steam utilization.

**ME 108 Heat and Mass Transfer** **2+0 Sem. II**

Concept and modes of heat transfer. Conduction: Thermal conductivity of materials, general differential equation of conduction. One dimensional steady state conduction through plane and composite walls, tubes and spheres. Electrical analogy. Insulation materials. Fins, Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis. Useful non dimensional numbers. Equation of laminar boundary layer on flat plate and in a tube. Laminar forced convection on a flat plate and in a tube. Combined free and forced convection. Radiation: Introduction, absorptivity, reflectivity and transmissivity. Black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks. Heat exchangers: Types, fouling factor, log mean temperature difference, heat exchanger performance, transfer units, analysis of parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

**ME 201 Heat and Mass Transfer in Food Processing** **2+1 Sem. I**

**(For students of College of Agriculture) (Practical part to be taught by Dept. of Processing And Food Engineering)**

Basic heat transfer processes, coefficients and related properties. One-dimensional steady state conduction: theory of heat conduction, Fourier's law and its derivation, concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines. One-dimensional steady state heat conduction with heat generation: heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform and non-uniform heat generation, temperature distribution equations with different boundary conditions. Steady-state heat conduction with heat dissipation to environment: introduction to extended surfaces (fins) of uniform area of cross-section and with equation of temperature distribution with different boundary conditions, effectiveness and efficiency of the fins. Introduction to unsteady state heat conduction: system with negligible internal resistance and in various geometries. Convection: forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, important empirical relations used for determination of heat transfer coefficient, heat transfer to flowing fluids. Radiation: heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors. Introduction to condensation and boiling heat transfer: film and drop-wise condensation, effect of non-condensable gases, boiling heat transfer. Heat exchangers: introduction, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design, application of different types of heat exchangers in dairy and food industry. Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

**Practical:** Heat transfer analysis during conduction and convection. Study on various types of heat exchangers used in food industry. Preparation and calibration of thermocouples. Determination of thermal conductivity of different food products. Study of working principle and constructional details of plate heat exchanger and shell & tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in high temperature short time (HTST) pasteurizer.

**ME 202 Fluid Mechanics and Open Channel Hydraulics** **2+1 Sem. II**

Properties of fluids: ideal and real fluid. Pressure and its measurement. Pascal's law. Pressure forces on plane and curved surfaces, centre of pressure, buoyancy, metacentre and metacentric height, condition of floatation, stability of submerged and floating bodies. Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow: translation, rotation, circulation and vorticity, vortex motion. Dynamics of fluid flow: Bernoulli's theorem, venturimeter, orifice meter, nozzle, siphon. Laminar flow: stress-strain relationship, flow between infinite parallel plates both plates fixed, one plate moving,

discharge, average velocity. Laminar and turbulent flow in pipes. Darcy's equation for head loss, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic and energy gradient. Flow through orifices (Measurement of discharge and time). Flow through mouthpieces. Flow over notches and weirs. Chezy's formula for loss of head in pipes. Flow through simple and compound pipes. Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, velocity and pressure profiles in open channels, hydraulic jump. Dimensional analysis and similitude: Rayleigh's method and Buckingham's pi-theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery: pumps and turbines.

**Practical:** Study of manometers and pressure gauges. Verification of Bernoulli's theorem. Determination of coefficient of discharge of venturi-meter and orifice meter. Determination of coefficient of friction in pipeline. Determination of coefficient of discharge for rectangular and triangular notch. Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice. Determination of coefficient of discharge for mouth piece. Measurement of force exerted by water jets on flat and hemispherical vanes. Determination of meta- centric height. Determination of efficiency of hydraulic ram. Performance evaluation of Pelton and Francis turbine. Study of current meter. Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

**ME 207 Theory of Machines** **2+0 Sem. II**

Elements, links, pairs, kinematics chain and mechanisms. Classification of pairs and mechanisms, lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration using graphical method (relative velocity and acceleration, instantaneous centers). Introduction to spur, helical, spiral, bevel and worm gears, law of gearing, nomenclature, velocity of sliding between two teeth in mesh, involute and cycloidal profile for gear teeth, interference and undercutting. Simple, compound, reverted and epicyclic trains, determining velocity ratio by tabular method. Flywheel: introduction and applications, turning moment diagrams, coefficient of fluctuation of speed and energy. Belt drives: types, materials and length of belt, power transmitted, velocity ratio, belt size for flat and V belts, effect of centrifugal tension, creep and slip on power transmission. Chain drives. Friction: types, laws of dry friction, friction of pivots and collars, single disc, multiple disc, and cone clutches, rolling friction, anti friction bearings. Governors: types, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves, sensitiveness, stability, hunting, isochronism, power and effort of a governor. Static and dynamic balancing, balancing of rotating masses in one and different planes.

**ME 208 Thermodynamics, Refrigeration and Air Conditioning** **2+1 Sem. I**

Thermodynamic properties and systems, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in non-flow and steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamic process. Principles of refrigeration, units, terminology, production of low temperatures, vapour refrigeration mechanism, P-V, T-s, P-h diagrams (or) Mollier diagram, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning: principles, types and functions of air conditioning, physiological principles in air conditioning. Air distribution and duct design methods, fundamentals of design of complete air conditioning systems. Humidifiers and dehumidifiers. Cooling load calculations. Types of air conditioners and their applications.

**Practical:** Study and numerical on thermodynamic air cycles (Otto, diesel and dual cycles), Study and application of P-V, T-s and P-h chart in refrigeration. Numerical on air refrigeration cycle (reverse Carnot cycle and Bell Coleman cycle), Numerical on vapour compression cycle refrigeration. Study of domestic water cooler, domestic household refrigerator, absorption type solar refrigeration system. Study of cold storage for fruit and vegetables, Freezing load and time calculations for food materials, Determination of refrigeration parameters using refrigeration tutor–II test rig, Numerical on design of air conditioning systems, Study of window air conditioner, Study on repair and maintenance of refrigeration and air-conditioning systems. Visit to chilling or ice making and cold storage plants.

**ME 302 Machine Design** **2+0 Sem. I**

Design: introduction, phases and considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded joints subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints subjected to shear and eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs. Design of flat belt and V-belt drives and pulleys. Design of spur gear. Design of screw motion mechanisms like screw jack and lead screw etc. Selection of anti-friction bearings.

**ME 305 Fluid Mechanics** **2+1 Sem. II**

**(For students of College of Agriculture)**

Fluid properties, compressible and non-compressible fluids, flow behavior of viscous foods. Surface tension, capillarity. Static pressure of liquids: hydraulic pressure, absolute and gauge pressure, pressure head of a liquid, pressure on vertical rectangular surfaces. Pressure measuring devices: simple, differential, micro-manometer, inclined manometer, mechanical gauges, piezometer. Floating bodies: Archimedis' principle, stability and equilibrium of floating bodies, metacentric height. Fluid flow: classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation, Bernoulli's theorem and its applications. Navier-Stokes equations in cylindrical co-ordinates, boundary conditions, simple application of Navier-Stokes equation. Laminar flow between two straight parallel boundaries. Flow past through the immersed solids, packed and fluidized beds. Flow through pipes: loss of head, determination of pipe diameter, discharge, friction factor, critical velocity. Flow through orifices, mouthpieces, notches and weirs, vena-contracta, hydraulic coefficients, discharge losses, time for emptying a tank, loss of head due to contraction, enlargement at entrance and exit of pipe, external and internal mouthpieces. Types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, rotameter, water level point gauge, hook gauge. Dimensional analysis: Buckingham's pi- theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude. Turbines and pumps: classification, centrifugal, submersible, reciprocating and positive displacement pumps. Centrifugal pumps: pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometric efficiency, operating characteristics of centrifugal pumps, submersible pumps. Reciprocating pumps: working of single and double-acting pumps, instantaneous rate of discharge, acceleration of piston and water. Gear pump: pressure variation, work efficiency. Pressure requirements for viscous foods to lift them to different heights and selection of pumps. Open channel hydraulics: classification of open channel and definitions, most economical sections of regular cross-sections, specific energy concept, critical depth, energy diagrams, velocity and pressure profiles in open channels, hydraulic jumps and types.

**Practical:** Study of different tools and fittings. Study on flow rate versus pressure drop with U-tube manometer. Verification of Bernoulli's theorem. Determination of discharge coefficient for venturi, orifice, V-notch and weir. Verification of emptying time formula for a tank. Determination of critical Reynold's number by Reynold apparatus. Study of reciprocating, centrifugal and gear pump. Calibration of rotameter. Study of different types of valves. Study of pumps for viscous fluid. Determination of meta-centric height. Determination of coefficient of friction in pipeline. Determination of coefficient of discharge of venturimeter and orificemeter.

## Elective Course

**ME 404 Mechatronics** **2+1 Sem. II**

**(In collaboration with Dept. of Electrical Engineering and Information Technology)**

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach. Sensors and transducers, performance terminology, displacement, position & proximity sensors, photo-electric transducers, flow transducers, optical sensors and transducers. Actuators, mechanical actuation systems, hydraulic & pneumatic actuation systems, electrical actuation

systems, A.C. Motor, D.C. Motor, stepper motor. Signal conditioning process, filtering digital signal, multiplexers, data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems. System modelling& control, mathematical models, engineering systems, electro-mechanical & hydraulic-mechanical systems, modelling dynamic systems, transfer functions, control modes, PID controller. Micro-processor & computer, computer and interfacing, micro-computer structure, micro-controllers, application of microcontrollers, PLC. Robotics, robot components, robot classification and specification, work envelopes, other basic parameters of robots. Robot applications, robot applications in manufacturing, material transfer and machine loading/unloading, processing operations like welding & painting, assembly operations, inspection automation, future applications.

**Practical:** Selection of sensor for a particular application from catalogue/internet. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

## Postgraduate Courses

**ME-501 Mechatronics and Robotics in Agriculture** **2+0** **Sem. I**

**Unit I** Introduction to mechatronics: Basic definitions, key elements of mechatronics, historical perspective, the development of the automobile as a mechatronic system. Mechatronic design approach, functions of mechatronic systems, ways of integration, information processing systems, concurrent design procedure for mechatronic systems.

**Unit II** System interfacing, instrumentation, and control systems.Input/output signals of a mechatronic system, signal conditioning, microprocessor control, microprocessor numerical control, microprocessor input/output control.

**Unit III** Microprocessor based controllers and microelectronics: Introduction to microelectronics, digital logic, overview of control computers, microprocessors and microcontrollers, programmable logic controllers, digital communications.

**Unit IV** Technologies of robot: Sub systems, transmission system (Mechanics), power generation and storage system, sensors, electronics, algorithms and software. Servo motor drives types and applications. Stepper motor and its concept. Industrial robots: Classification and sub systems. Defining work space area.

**Unit V** Application of robots in agriculture: Harvesting and picking, weed control, autonomous mowing, pruning, seeding, spraying and thinning, phenotyping, sorting and packing. Utility platforms. Use of different agrobots in agriculture.

**ME-502 Refrigeration Systems** **2+1** **Sem. I**

**Unit I** Reversed Carnot cycle, Carnot, Brayton and aircraft refrigeration systems.

**Unit II** Vapour compression refrigeration systems: Use of p-h chart, effect of pressure changes on COP, sub cooling of condensate on COP and capacity, super heating, single stage, multi- stage and cascade systems.

**Unit III** Vapour absorption systems: Theory of mixtures, temperature-concentration and enthalpy concentration diagrams, adiabatic mixing of two systems, diabatic mixing, throttling process, ammonia water and water lithium-bromide systems.

**Unit IV** Thermoelectric refrigeration systems: Advantages, comparison with vapour compression system. Vortex tube refrigeration system and its thermodynamic analysis. Ultra low temperature refrigeration. Ejection refrigeration. Water refrigeration: Centrifugal and steam jet refrigeration systems, characteristics of steam jet refrigeration system, effect of boiler efficiency on overall COP, actual steam jet system, two-fluid jet refrigeration.

**Practical:** Numerical on air refrigeration cycle, Study of vapour compression refrigeration systems, Determination of the coefficient of performance of the refrigeration system, Study of vapour absorption

(electrolux) refrigeration systems, Study and application of P-V, T-s and P-h chart in refrigeration, Study and performance testing of domestic refrigerator, Study of domestic water cooler, Study of actual and theoretical COP of Cascade Refrigeration System, Visit to cold storage plants.

**ME-503 Mechanism Analysis and Synthesis** **2+1** **Sem. I**

**Unit I** Kinematics of mechanisms, analysis and synthesis, mobility, systematic of mechanisms, deriving other mechanisms from linkages, Relative motion, instantaneous center method, Kennedy's theorem. Graphical and analytical methods of kinematic analysis.

**Unit II** Computer - Aided analysis of mechanisms. Synthesis of linkages for path generation, function generation, Graphical techniques. Relative pole method and method of inversion. Analytical kinematics synthesis of linkages, Freudenstein's method, Loop closure equations based on complex variable approach

**Unit III** Gears and their motion-Analysis and Synthesis of epicyclic gear trains.

**Unit IV** Cams-follower system; standard follower motions and combinations, importance of follower acceleration in cam system dynamics, terms related to cam design - their importance. Cam synthesis - graphical cam profile layout for a desired follower motion. Analytical determination of cam profile co-ordinates for disc cam operating common types of follower.

**Practical** : Graphical solutions of mechanisms relating to velocity and acceleration. Problems on computer-aided analysis and synthesis of mechanisms. Analysis and design problems of gear trains, cam profile design.

**ME-504 Vibrations** **3+0** **Sem. I**

**Unit I** Vibration motion and its terminology. Undamped free vibrations, equations of motion- natural frequency. Energy method, Rayleigh method; effective mass principle of Virtual work. Equivalent spring stiffness in parallel and in series. Harmonic analysis and Fourier Series

**Unit II** Damping - viscous, solid, coulomb equivalent dampers. Viscosity damped free vibrations, Logarithmic decrement. Forced vibrations with harmonic excitation and rotating unbalance. Energy dissipated by damping

**Unit III** Forced vibration with damping, Vibration isolation and force and motion transmissibility. Two degree of freedom systems. Principal modes of vibration, co-ordinate coupling. Vibration absorbers

**Unit IV** Free vibration equation of motion for multi-degree of freedom systems. Influence coefficients and Maxwell's reciprocal theorem, stiffness coefficients. Numerical methods for finding natural frequencies for multi-degree of freedom systems.

**Unit V** Vibration of lumped parameter systems and continuous systems. Lagrange equations. Vibration measuring instruments, Vibrometers, velocity pickups, Accelerometer and frequency measuring instruments. Applications of vibrations. Vibration control, balancing of rotating and reciprocating machines, design of vibration isolators.

**ME-505 Thermal Environmental Engineering** **3+0** **Sem. I**

**Unit I** Requirements of temperature and moisture in food preservation, processing, storage, animal and plant production systems, human comfort etc.; Thermodynamic properties of moist air, psychrometric chart, psychrometric processes and applications;

**Unit II** Mass transfer and evaporation of water from free surfaces, theory of psychrometer, direct contact transfer processes between moist air and water-air washer, cooling tower, heating and cooling of moist air by extended surface coils, dehumidification using moisture absorbing materials;

**Unit III** Solar irradiations on structures, calculation of heating and cooling loads in buildings/ storage structures; Design of air conditioning systems, air distribution and duct design, air flow pattern and control, equipment, components and controls.

**Unit IV** Instruments for measurement and control of temperature and moisture; Thermal insulation materials for environmental control systems, applications of environmental control in green house, dairy industry, potato storage etc.

**ME-506 Thermodynamics** **3+0 Sem. I**

**Unit I** Review of basic laws. Availability; Irreversibility and availability analysis of engineering processes, Second law efficiency, Second law analysis of closed systems, steady flow systems and unsteady flow systems.

**Unit II** Thermodynamic property relations: Maxwell relations, Helm-holt and Gibbs free energy, criteria of equilibrium. Other equations of state: Vander Walls equation of state, Beattie- Bridgeman equation of state, Bertholet equation of state, Dieterici equation of state, Virial equations of state. The Ideal-Gas Equation of State, compressibility factor, law of corresponding states and generalized compressibility chart. Relations involving enthalpy, internal energy and entropy.

**Unit III** Gas Mixtures: Fugacity of real gases. Chemical potential and the perfect gas mixture, P-V-T behavior of gas mixtures, Clausius-Clapeyron and Gibbs-Duhem equations.

**Unit IV** Chemical Reactions: Reactive mixtures. Fuels and combustion, Theoretical and actual combustion processes, Enthalpy of formation and reaction, internal energy of reaction, adiabatic reaction temperature, chemical affinity, free energy and chemical equilibrium, First and Second law analysis of reactive mixtures.

**Unit V** Irreversible thermodynamics and direct Energy Conversion systems: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydronamic generations, Photovoltaic cells.

**ME-507 Fatigue Design** **2+1 Sem. II**

**Unit I** Theories of failure, maximum normal stress, maximum shear stress and distortion energy theory, failure of ductile materials, failure of brittle materials.

**Unit II** Stress concentration and its evaluation, stress concentration of ductile and brittle materials under static loading and under dynamic loading, determining geometric stress concentration factors, designing to avoid stress concentration.

**Unit III** Fatigue of machine components, mechanism of fatigue failure, fatigue failure models and their considerations in design of machine elements, fatigue loads. Fatigue testing and presentation of fatigue data. Influence of stress conditions on fatigue strength/endurance limit of metals. Low and high cycle fatigue

**Unit IV** Cumulative fatigue damage. Designing for finite and infinite life. Improving fatigue resistance of machine elements. Stress corrosion. Corrosion fatigue.

**Practical :** Fatigue tests on testing machine(s) for specimens of different materials having different discontinuities/stress raisers and various surface conditions. Determination of correlation between fatigue limit and ultimate strength of material. Problems in fatigue design of common machine component.

**ME-508 Vibration and Noise Control** **3+0 Sem. I**

**Unit I** Introduction, Methods of vibration control, design of vibration absorbers, undamped dynamic absorber, centrifugal pendulum absorber, dry friction damper, untuned viscous damper.

**Unit II** Vibration control by structural design, changing the dynamic characteristics of a structure, structural dynamics modification. Vibration and shock isolation, materials used for isolators, force transmissibility, velocity transmissibility, Application and design of isolators, design of isolators in machine foundations, balancing of rotating machinery, rotor balancing, active vibrations control.

**Unit III** Vibration level under optimum conditions, Acoustic plane waves governing equations, energy density, intensity and impedance, noise source identification, noise in machines, fan and flow noise, combustion noise, noise in piping systems.

**Unit IV** Wave analysis of structures and spaces, characteristics of duct and cabin noise, stationary modes, random noise, measures of a sound acoustic design, importance of reverberations time, various types of acoustic testing chambers, noise measurement and control instruments, sound intensity mapping noise isolation design, noise absorber design, design of silencers, mufflers, acoustic design of buildings.

**ME-509 Bearings and Lubrication** **2+0 Sem. II**

**Unit I** Theory of lubrication, Plain (Sliding-Contact) bearings, basic types of friction in plain bearings, design of hydrodynamic bearings.

**Unit II** fluid friction in bearings, antifriction properties of materials, bearings materials, Microgeometry of bearing surfaces, self-aligning, floating bushings, high speed and vibration-proof bearings.

**Unit III** Lubricants and lubrication systems, types and properties of additives used in lubricants, antifriction (Rolling- elements) bearings, types of rolling element bearings, co-efficient of rolling friction, allowable peripheral speeds, load-carrying capacity and durability

**Unit IV** Selection of bearing series, high speed bearings, high temperature bearings, design of ball and roller bearings and their lubrication, Mounting of rolling bearings on shafts and installation in the housings.

**ME-510 Industrial Heat Transfer** **3+0 Sem. I**

**Unit I** Introduction and Basic Concepts: Three modes of heat transfer, physical origins and rate equations, importance of heat transfer, heat transfer analysis involving conduction, convection and radiation.

**Unit II** Heat Conduction: Fourier's law, thermal conductivity of matter, heat diffusion equation for isotropic and anisotropic media, steady versus transient heat transfer, boundary and initial conditions, heat generation. Conduction in solids, derivation of general equation of conduction in rectangular, cylindrical and spherical coordinates, one-dimensional steady-state heat conduction through a plane wall, a cylinder and a sphere with and without heat generation. Heat transfer from extended surfaces, radial fins and fin optimization; heat conduction with two or more independent variables. Unsteady state heat conduction – lumped capacitance method and its validity, plane wall and radial systems with convection, semi-infinite solid, multi-dimensional transient heat conduction.

**Unit III** Convection: Dimensional analysis approach, physical significance of dimensionless parameters, similarity parameters from differential equations, review of Navier Stokes equations and dimensional analysis applications, external flow over bodies, internal flow through bodies.

**Unit IV** Radiation: Processes and properties, view factor, radiation between black and grey surfaces, radiation combined with convection and conduction.

**Unit V** Heat exchangers: Types of heat exchangers, overall heat transfer coefficient, heat exchanger analysis using Log Mean Temperature Difference and Effectiveness-NTU method for parallel, counter, multipass and crossflow heat exchangers, methodology for heat exchanger calculation, compact heat exchangers, passive and active heat transfer enhancement methods in heat exchangers.

**ME-511 Conduction and Radiation Heat Transfer** **3+0 Sem. II**

**Unit I** Review of classical heat conduction fundamentals. Fourier's law of heat conduction, Initial and Boundary conditions, Steady and unsteady heat conduction problems and their solutions in Cartesian, cylindrical and spherical coordinates Fin analysis and optimisation of find dimensions and insulation thickness.

**Unit II** Unsteady state Heat Transfer conduction: I-D Transient heat conduction- Lumped system analysis, and solutions by use of Heisler charts. Second order lumped capacity system.

**Unit III** Conduction heat transfer with phase change: Melting and solidification and its analytical solution. Introduction to the numerical approach for modelling solid-liquid phase change. Limitations of numerical and analytical approach.

**Unit IV** Radiation heat transfer ; Review of fundamentals, Laws of Radiation, Intensity of Radiation, Irradiation, Radiosity, Radiative properties of surfaces, Radiation exchange between surfaces, View Factor, Radiation exchange in a black enclosure, Radiative heat transfer in participating media(Gas Radiation), Radiative Transfer Equation. Radiation calculation using radiosity approach. Introduction to atmospheric radiations, Inverse problems in radiation.

**ME-512 Ideal Fluid Flow** **3+0 Sem. II**

**Unit I** Review of mathematical back ground. Introduction of fluid machines. Historical background and fluid kinematics. Types of fluids and motions, continuity equation in cartesian and cylindrical-polar coordinates, velocity and acceleration, free and forced vortex flow, characteristics and utility of flownets.

**Unit II** Eulerian and Lagrangian description of flow; Motion of fluid element translation, rotation and deformation, vorticity and strain-rate tensors, Continuity equation, Cauchy's equations of motion, Derivation of Navier-Stokes equations for compressible flow. Properties of Navier-Stokes equation.

**Unit III** Plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stokes first and second problems, flow near a rotating disk, flow in convergent-divergent channels.

**Unit IV** Integration of equation of motion and derivation of Bernoulli's theorem and energy integral relation. Potential and stream functions, properties of potential and stream functions, equipotential lines and lines of constant stream function, Relationship between potential and stream functions.

**Unit V** Convectivity and cycle motions, boundary effects on ideal fluid motions and methods of acquiring potential solutions, important cases.

**ME-513 Solar Energy Utilization** **3+0 Sem. II**

**Unit I** Extra-terrestrial radiation, atmospheric attenuation, radiation intensity. Solar geometry, basic angles and derived angles, incidence angle on general inclined surfaces, irradiance on titled surfaces.

**Unit II** Flat plate collectors, top loss coefficient, heat removal factor, performance of flat plate collectors, all glass collectors. Evacuated solar collector, solar air heating systems.

**Unit III** Types of concentrators, non tracking and tracking concentrators; linear and point focusing concentrators, tracking methods, Solar distillation, effect of various parameters on distillate output, other designs of solar still, Storage of solar energy.

**Unit IV** Rock bed storage, Latent heat storage, Photovoltaic systems. Analysis of solar ponds and solar stills, solar crop dryings systems. Other applications of solar energy like greenhouse, biogas plant, solar cooker.

**ME-514 Steam Power Engineering** **3+0 Sem. I**

**Unit I** Fuels and their properties, combustion, stoichiometry. Types of combustion processes, flame temperature, flame structure, flame propagation and stability.

**Unit II** Pulverized Coal Burners, Pulverized Coal Supply, Burner Arrangement, Downshot Firing, Horizontal Firing, Tangential Firing, Burner Types, Wall Burners, Corner Burners, Low NOx Burners, Ignition Equipment, Cyclone Furnaces, Principles, Configuration, Operation, Stokers, Principles, Retort Stokers, Mass Feed Stokers, Spreader Stokers, Fluidized Beds, Principles, Bubbling Fluidized Bed, Circulating Fluidized Bed.

**Unit III** Design of combustion equipment. Boilers and their accessories, Cornish boiler, Lancashire boiler, Locomotive boiler, Reversal Chamber, Wet Back Boilers, Dry Back Boilers, Two pass boilers, Heat exchangers, superheaters and reheaters, economizers, air pre-heaters, feed water heaters, evaporators and condensers.

**Unit IV** Steam turbines, impulse and reaction turbine. Velocity diagram and work done, stage efficiency, multi-staging and bleeding.

**Unit V** Steam consumption and conservation.

**ME-515 Computer Aided Design** **2+1 Sem. II**

**Unit I** Introduction to computer aided design, scope of computer aided machine design, design process and design environments. Geometric modeling and interactive graphic, engineering analysis, design review and automated drafting, modeling, viewing.

**Unit II** Solid modeling, boundary representation, constructive solid geometry, feature based modeling. Computer aided analysis and synthesis of common mechanical components, a bar, a beam and a shaft, comparison with analytical results.

**Unit III** Application of numerical methods and optimization techniques to machine design problems, Computer aided selection of standard mechanical components. Introduction to FEM. FEA using two dimensional and three dimensional elements; plain strain and plainstress problems, finite element mesh, automatic meshing techniques, limitations of FEM.

**Practical :** Computer aided design problems for machine components, use of standard software, CAD models for other applications. Development of FEM models for analysis of a bar, beam and a shaft. Practice in using an FEM software on other real life problems like spanners, connecting rods.

**ME-516 Analysis of Robot Manipulators** **3+0** **Sem. II**

**Unit I** Introduction, major components of robotic systems, types of robots, classification based on mechanical configuration, motion configuration, roll, pitch and yaw angles, work space, performance measure, application of robots, controllers and actuators, control system analysis.

**Unit II** Position sensors, velocity sensors, pneumatic and hydraulic actuators, end- effectors, types, mechanical grippers, gripper force analysis, selection of gripper and their synthesis, external sensors, tactile sensors, sensors based systems, sensors in robotics.

**Unit III** Manipulator kinematics, position representation, forward and reverse transformation of the 2-degrees of freedom, 4 degrees of freedom manipulator in three dimensions, kinematic equations using homogeneous transformations, manipulator path control, Differential relationships.

**Unit IV** Dynamics of a robot, dynamic equations, real-time control and simulation, identification of load, control of a single and a multilink manipulator. Static forces, compliance, programming methods, functions and environment, robot programming languages, on-line and off-line programming languages, artificial intelligence and its techniques, application of artificial intelligence, performance capabilities, features and technical data of robots.

**ME-517 Viscous Flow and Convective Heat Transfer** **3+0** **Sem. II**

**Unit I** Fundamental Equations of Viscous Flow: Conservation of Mass, Momentum and Energy, Finite Volume Approach, Derivation of Continuity Equation: conservative and non conservative form, Derivation of Navier-Stokes (N-S) equations for Compressible Flow, Stokes Hypothesis.

**Unit II** Parallel flow through straight channel, coquette flow, flow through pipe and flow between concentric rotating cylinders.

**Unit III** Derivation of the conservation equations; continuity, momentum and energy equation. Laminar boundary layer equations. Boundary layer similarity parameters.

**Unit IV** Heat Transfer in Laminar internal flows: The energy differential equations for flow through a circular pipe, The circular tube with fully developed velocity and temperature profiles, Solutions for tubes of non circular cross section with fully developed velocity and temperature profiles, circular tube thermal entry length solutions.

**Unit V** Heat transfer in External boundary layers: Constant free-stream velocity flow along a constant Temperature semi-infinite plate with and without injection or suction, Non similar thermal boundary layers, constant free stream velocity flow along a semi-infinite plate with unheated starting length.

**ME-518 Computer Integrated Manufacturing** **3+0** **Sem. II**

**Unit I** Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Objectives and Benefits of FMS - Basic Components of FMS and their integration in the data processing systems - Types of FMS - FMS Layouts, Differences between FMC and FMS. DNC based factory management and control, Integrated CAD/CAM system and shared database.

**Unit II** Concept and terminology of Group Technology, Part family formation, Classification and coding systems for components, Group Technology machine cells. CAPP and route sheet development, CAPP system, Computer aided plant layout. Equipment and their functions. Integration of Robots in CIMS,

Automatic Storage and Retrieval Systems (AS/RS), Carousel, Palletization and fixtures.

**Unit III** Introduction to Rapid Prototyping, and Rapid Tooling: Reverse Engineering. Concept of concurrent engineering. Product life cycle management.

**Unit IV** Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.

**ME-519 Automation, CNC Machines and Robotics** **3+0** **Sem. II**

**Unit I** Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Automated flow lines, its configurations, methods of work part transport, transfer mechanisms.

**Unit II** Basic concept of pneumatic logic circuits, Logic functions and elements, Types of logical gates, Types of elements for pneumatic valves, various electrical and electronic control devices such as Solenoid, Counters, Programmable logic controllers.

**Unit III** Introduction to NC, CNC and DNC Machines, Basic components of an NC machine, Different types of NC Machine, Advantages and disadvantages of NC machines, Difference between CNC and DNC machine, Basic structure of CNC machine, Problems in NC machines, Functions of CNC machines, Advantages of CNC machines. CNC Programming, Input in CNC, Types of CNC programming, List of basic G codes and M codes, CNC programming for lathe machines, programming of simple components in turning, drilling and milling systems, programming with canned cycles, Cutter radius compensations.

**Unit IV** Automation and Robotics, Historical Development, Robot definitions related to automation, Basics of a robotic system, Robot Actuators. Robot controllers, Motion control of robots, Types of robot controls, Concepts about Basic Control System, Different Types of Controllers-Proportional, Integral, Differential, PID controllers.

**ME-591 Seminar** **1+0**

**ME-599 Master's Research** **0+30**

## Ph.D Courses

**ME-601 Advanced Conductive Heat Transfer** **3+0** **Sem. I**

**Unit I** Review of heat transfer, Simultaneous heat transfer mechanism. Steady state heat conduction problems, Concept of variable thermal conductivity, hyperbolic heat conduction, Building heat conduction especially walls and roof.

**Unit II** Transient heat conduction: Lumped system analysis, Transient heat conduction in walls, cylinder and spheres, Bessel's equation and Bessel and error functions, Semi-infinite media, Laplace Transformation.

**Unit III** Moving interface problems: Stefan's problem. Neumannn problem, Conduction with Phase Change (Melting and Solidification) and its analytical solution. Applications of phase change materials. Introduction to the numerical approach for modelling solid-liquid phase change.

**Unit IV** Numerical methods in heat conduction: Limitations and complications with analytical approach. Concept of numerical model. Finite difference formulation of differential equations, One dimensional steady state equation, boundary conditions

**Unit V** Introduction to micro scale heat conduction: Micro scale and relevant length scales, Physics of energy carriers, Energy storage and transport, Limitations of Fourier's law and first regime of microscale heat transfer, solutions and approximations of first regime of micro scale heat transfer.

**ME-602 Advanced Convective Heat Transfer** **3+0** **Sem. I**

**Unit I** Conservation Principles, Multicomponent Mixtures, Fundamentals of Diffusive Mass Transfer, Boundary and Interfacial Conditions, Transport Properties, The Continuum Flow Regime and Size Convention for Flow, Numerical Problems.

**Unit II** Boundary Layer on a Flat Plate, Laminar Boundary-Layer Conservation Equations, Laminar Boundary-Layer Thicknesses, Boundary-Layer Separation, Non dimensionalization of Conservation Equations and Similitude, Numerical Problems.

**Unit III** Hydrodynamics of Flow Parallel to a Flat Plate, Heat and Mass Transfer During Low-Velocity Laminar Flow Parallel to a Flat Plate, Heat Transfer During Laminar Parallel Flow Over a Flat Plate With Viscous Dissipation, Hydrodynamics of Laminar Flow Past aWedge, Heat Transfer During Laminar Flow Past a Wedge, Effects of Compressibility and Property Variations.

**Unit IV** Couette and Poiseuille Flows, The Development of Velocity, Temperature, and Concentration, Hydrodynamics of Fully Developed Flow, Fully Developed Hydrodynamics and Developed Temperature or Concentration Distributions, Fully Developed Hydrodynamics, Thermal or Concentration Entrance Regions, Combined Entrance Region.

**Unit V** Laminar–Turbulent Transition and the Phenomenology of Turbulence, Fluctuations and Time (Ensemble) Averaging, Reynolds Averaging of Conservation Equations, Eddy Viscosity and Eddy Diffusivity. Universal Velocity Profiles, The Mixing-Length Hypothesis and Eddy Diffusivity Models, Temperature and Concentration Laws of the Wall, Kolmogorov Theory of the Small Turbulence Scales, Flow Past Blunt Bodies.

**Unit VI** Hydrodynamics of Turbulent Duct Flow, Universal Temperature Profile in a Circular Duct, Fully Developed Hydrodynamics, Thermal Entrance Region, Combined Entrance Region

**Unit VII** Reynolds-Averaged Conservation Equations and the Eddy Diffusivity Concept, One-Equation Turbulence Models, Near-Wall Turbulence Modeling and Wall Functions, The Reynolds Stress Transport Models, Algebraic Stress Models, Turbulent Models for Buoyant Flows, Direct Numerical Simulation, Large Eddy Simulation.

**ME-603 Design of Solar Energy Systems** **3+0** **Sem. I**

**Unit I** Review of solar radiation intensity and solar geometry. Analysis and design of non-concentrating and concentrating solar collectors.

**Unit II** Solar energy storage techniques, Steady and transient heat transfer analysis of solar cookers, solar ponds, solar stills and solar dryers.

**Unit III** Design of solar thermal systems; hot water systems, space heating and cooling systems, refrigeration systems, power generation systems, solar drying system for agricultural produce, Greenhouse heating and cooling systems design, Thermal analysis and modeling of greenhouse system coupled with heating and cooling systems, optimum greenhouse design for crop drying applications.

**Unit IV** Design of solar photovoltaic systems, Stand alone systems, Independent power generation systems, Grid connected systems. Economic analysis of solar energy systems.

**ME-604 Advanced Combustion** **3+0** **Sem. II**

**Unit I** Introduction: Importance of combustion, combustion equipment hostile fire problems, pollution problems arising from combustion.

**Unit II** Thermodynamics of Combustion: Enthalpy of formation, enthalpy of reaction, heating values, first and second law analysis of reacting systems, chemical equilibrium, equilibrium composition, adiabatic and equilibrium flame temperature.

**Unit III** Kinetics of Combustion: Law of mass action, reaction rate, simple and complex reactions, reaction order and molecularity, Arhenius Law, activation energy, Chain reaction steady state and partial equilibrium approximations. Chain explosion, Explosion limits and oxidation characteristics of hydrogen, carbon monoxide and hydrocarbons.

**Unit IV** Flames: Premixed Flames: structure and propagation of flames in homogeneous gas mixtures; simplified Rankine Hugoniot relations; properties of hugoniot curve; analysis of deflagration and detonation branches, properties of Chapman Jouguet wave. Laminar flame structure; Theory of Premixed laminar flames: Mallard and Le Chatelier's thermal theory, Comprehensive theory of Zel' dovich, Frank

Kamenetky and Samenov and diffusion theory of Tonford and Peace. theories of flame propagation and calculation of flame speeds, flame speed measurements. Stability limits of laminar flames; flammability limits and quenching distance; bumer design. Mechanisms of flame stabilization in laminar and turbulent flows; flame quenching. Diffusion flames; comparison of diffusion with premixed flame. Combustion of gaseous fuel jets Burke and shumann development.

**Unit V** Burning of Condensed Phase: General mass burning considerations, combustion of fuel droplet in a quiescent and convective environment. Introduction to combustion of fuel sprays.

**Unit VI** Ignition: Concepts of ignition, chain ignition, thermal spontaneous ignition, forced ignition.

**Unit VII** Combustion Generated Pollution &its Control: Introduction, nitrogen oxides thermal fixation of atmospheric nitrogen prompt NO, thermal NOx formation and control in combustors Fuel NOx and control, post—combustion destruction of NOx, Nitrogen dioxide carbon monoxide oxidation — quenching, hydrocarbons, sulphur oxides.

**ME-605 Computational Heat Transfer and Fluid Flow** **3+0** **Sem. II**

**Unit I** Basics of heat transfer and fluid flow. Mathematical description of fluid flow and heat transfer: conservation equations for mass, momentum, energy, classification of partial differential equations.

**Unit II** Discretization methods: Finite difference methods: Taylor-Series and control volume formulations. Finite element discretization techniques. Mesh generation practice on simple rectangular geometries.

**Unit III** Modelling of diffusion problems using finite volume method; One dimensional steady state diffusion problems; discretization technique. Solution methodology for linear and non-linear problems, TDMA. One dimensional steady state heat conduction problems solving using numerical methods

**Unit IV** Flow modelling: Discretization of incompressible flow equations. Pressure based algorithm: SIMPLE, SIMPLER etc. Introduction to turbulence modelling

**Unit V** Demonstration and practice of test cases with a display of working CFD code and details

**ME-691 Seminar I** **1+0**

**ME-692 Seminar II** **1+0**

**ME-699 Ph. D. Research** **0+75**

# DEPARTMENT OF RENEWABLE ENERGY ENGINEERING

**PROGRAMME**

**Ph.D.**

**COURSE REQUIREMENTS**

| | |
|---|---|
| Field of Specialization | Renewable Energy Engineering |
| Required Courses | REE-601, REE-602, REE-603,REE-605 |
| Supporting Courses | Courses from subject matter fields (other than Major and Minor) related to area of special interest and research problem can be taken as per recommendations of the student's advisory committee. |
| Minor Field | Farm Machinery and Power Engineering, Processing and Food Engineering, Soil and Water Conservation Engineering, Irrigation and Drainage Engineering or any other as approved by the Dean Postgraduate Studies. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**EST 201 Fundamentals of Renewable Energy Sources** **2+1** **Sem. I**

Concept and limitations of Renewable Energy Sources (RES), potential and classification of RES. Solar, wind, geothermal, biomass and ocean energy sources. Comparison of renewable energy sources with non-renewable sources. Solar energy: energy available, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors. Different solar thermal devices, principle of natural and forced convection drying system and green house. Solar photovoltaic: p-n junctions, solar cells, SPV systems, stand-alone and grid connected solarpower station, calculation of energy through photovoltaic power generation and cost economics. Wind energy: energy available, general formula, lift anddrag, coefficient of performance, basis of wind energy conversion, effect of density, frequency variances, angle of attack and wind speed, types of wind mill rotors. Bioenergy: characteristics of biomass, pyrolysis of biomass to produce solid, liquid and gaseous fuels. Introduction to biomass gasification and gasifiers. Biomass cook-stoves. Biogas: fundamentals, biochemistry and factors affecting biogas generation, types and design consideration of domestic biogas plants, uses, applications and handling of bio-digested slurry.

**Practical:** Study of solar devices: cookers, water heating system, dryers, desalination unit and green house for agriculture production. Study and performance evaluation of different biogas plants and biomass gasifiers (throat less and downdraft). Study of biomass improved cook-stoves. Estimation of calorific value of biomass, biogas and producer gas.

**EST 202 Renewable Energy and Green Technology** **1+1** **Sem. II**

**(For Agriculture Students)**

Classification of energy sources, renewable energy sources and its contribution in agricultural sector, familiarization with biomass utilization for biofuel production and their applications. Biogas, familiarization with types of biogas plants and gasifiers, Gasification and gasifiers.Biomass briquetting. Bio-alcohol, biodiesel and bio-oil production and their utilization. Introduction of solar energy, collection and applications. Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation and solar photovoltaic system. Introduction to wind energy and its applications.

**Practical:** Familiarization with renewable energy gadgets.Study of biogas plants, gasifiers, production process of bio-fuels and briquetting machine.Familiarization with different solar energy gadgets. Study of solar photovoltaic system: solar light, solar pumping, solar fencing and solar rooftop. Study of solar cooker, solar dryer, solar distillation, solar pond and solar water heater.

**EST 301 Renewable Power Sources** **2+1** **Sem. I**

Energy consumption pattern and resources in India. Design and use of different commercial sized biogas plants, generation of power from biogas. Power generation from urban, municipal and industrial waste. Purification and bottling of biogas. History of small gas producer engine system. Power generation from biomass (gasification and Dendro thermal). Shaft power generation, thermal application. Solar thermal and photovoltaic systems for power generation, central receiver (Chimney) and distributed type solar power plants. Ocean thermal energy conversion (OTEC), magneto hydrodynamic generator (MHD). Hydrogen and fuel cell technology. Fuel cells and its associated parameters. Introduction of wind energy generators, working principle of wind power plants, wind farms. Mini, micro and small hydel plants. Cost economics of power generation.

**Practical:** Performance evaluation of solar water heater, solar cooker and solar air heater/dryer. Solar photovoltaic system and its characteristics. Effect of shading on photovoltaic panel. Diesel engine operation using dual fuel (diesel and biogas) and biogas alone. Visit to commercial/ institutional power generation biogas plant and biogas bottling plant.

**EST 302 Bio-Energy Systems: Design and Applications** **2+1** **Sem. II**

Assessment of available biomass and its analysis for bio-energy production, biomass preparation techniques for harnessing (size reduction, densification and drying). Fermentation processes and its general requirements, an overview of aerobic and anaerobic fermentation processes and their industrial applications. Heattransfer processes in anaerobic digestion systems, benefits and problems of anaerobic digestion, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species,methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Thermo-chemical degradation of biomass, principles of combustion,concept of excess air and chemistry of gasification. Gasifier fuels, properties, preparation and conditioning of producer gas. Trans-esterification for biodiesel production, Bio-hydrogen production routes, Environmental aspect of bio-energy,assessment of greenhouse gasmitigation potential.

**Practical:** Study of anaerobic fermentation system for industrial application, gasification for industrial process heat, biodiesel production system, biomass densification techniques (briquetting, pelletization and cubing), integral bio-energy system for industrial application and bio-energy efficiency in industry and commercial buildings. Study and demonstration of energy efficiency in building. Measuring efficiency of different insulation techniques. Study of Brayton, Stirling and Rankine cycles**.**

## Postgraduate Courses

**REE-501 Renewable Energy Technologies** **2+1** **Sem. I**

**Unit I** Solar Energy: Heat transfer, estimation and physical conversion, Instruments for measurement. Energy collection and analysis: FPC, ETC, concentrating collectors. Solar energy application: Direct and indirect. Solar photovoltaic technology: Conversion, Systems components, integrations and applications.

**Unit II** Energy from biomass and wastes: Production, distribution, characterization, treatments, recycling. Biomass conversion technologies: Thermo-chemical, bio-chemical and agro-chemical technology. Raw materials, process parameters, end products and utilization.

**Unit III** Wind energy: Resource estimation, technologies, performance curves, power and torque characteristics. Airfoils and rotors: Wind mill parameters, wind farms design and considerations.

**Unit IV** Alternate Energy Technologies: Ocean Thermal Energy Conversion, Geothermal, Tidal, Hydro. Energy conversion systems: Resources, systems integrations and analysis, applications. Energy storage: Types, materials, characteristics and application.

**Practical :** Analysis of solar collectors. Solar Photovoltaic cell characteristics, analysis of SPV systems. Characterization of biomass. Design and benefit analysis of energy systems. Design and efficiency testing of wind energy conversion devices.

**REE-502 Solar Thermal Energy Conversion Technologies** **2+1** **Sem. II**

**Unit I** Characteristics of solar radiation: Attenuation, absorption, scattering and air mass. Solar earth geometry.

**Unit II** Solar flux and weather data. Solar radiation data and estimation: Radiation estimation models and applications. Heat and mass transfer in solar energy utilization: Gray surface, sky radiation, radiation heat transfer coefficient, reflectivity, transitivity, transmittance absorption product. Selective surfaces and materials.

**Unit III** Solar thermal energy collectors (track and untrack): Heat capacity effect, time constant measurement, design and efficiency calculations, Fchart method utility.

**Unit IV** Techno-economic feasibility of solar thermal energy applications: Cooking, air heating for drying, steam generation, space heating and cooling, refrigeration, architecture, absorption cooling, thermal power generation.

**Practical :** Solar radiation measurement, estimation model applications, design of collectors, study of materials used in solar system. Energy balance and efficiency calculation of collectors.

**REE-503 Biomass Energy Conversion Technologies** **2+1** **Sem. I**

**Unit I** Biomass characterization: Types and resources, sustainability issues, assessment tools and methodologies, biomass fuel characterization, Biomass supply chain concept. Direct use of biomass: Size reduction, baling, pelletization, briquetting technologies.

**Unit II** Biochemical conversion of biomass: Feedstock, process design, operation, optimized process parameters and utilization for biogas and bioethanol production.

**Unit III** Biomass combustion: Stoichiometric air requirement, chemistry of combustion, design of combustion system, combustion zones, flame structure, stability, emissions. Co-firing of biomass.

**Unit IV** Thermo-chemical conversion of biomass: Feedstock, chemistry, reactor design, operation, optimized process parameters and utilization for gasification, carbonization, torrefaction and pyrolysis.

**Unit V** Cogeneration technologies: Cycles, topping, bottoming, selection, problems, applications. Waste heat recovery: Estimation, systems, design and application.

**Practical :** Biomass characterization. Design of bioreactors. Study of techno-economical feasibility of bio-chemical conversion process. Performance evaluation of combustion gadgets, gasifiers and pyrolytic converters. Design of waste heat recovery system.

**REE-504 Energy Auditing, Conservation and Management** **2+1** **Sem. II**

**Unit I** Energy conservation: Concepts, energy classification, equivalents, scenario, energy pricing, importance. Energy conservation act.

**Unit II** Energy auditing and economics: Energy management, energy audit strategy, types. Energy performance: Bench marking, fuel substitutions, energy audit instruments, material and energy balance. Energy conversion: Energy index, cost index. Financial management.

**Unit III** Thermal energy audit: Performance evaluation, energy conservation opportunities in boilers, steam system and furnaces, insulation, refractory's and other thermal utilities.

**Unit IV** Electrical Energy audit: Electrical systems, electricity billing, load management, power factor. Performance evaluation and energy conservation opportunities in motors, compressed air system, HVAC and refrigeration system, fans and blowers, pumps and lighting system.

**Unit V** Energy auditing and reporting in industries, Replacement of renewable energy technology option, case study in agro-industries.

**Practical :** Problems on energy index, cost index. Problems on material balance and energy balance. Financial management. Energy audit and conservation opportunities in thermal and electrical utilities. Case studies on energy audit and conservation.

**REE-505 Wind Energy Conversion and Utilization** **2+1** **Sem. I**

**Unit I** Wind mapping and assessment: Wind energy potential, nature of wind, Weibull and Rayleigh analysis, instruments, history and taxonomy of wind mills, wind power laws.

**Unit II** Wind turbine aerodynamics: Momentum theories, basic aerodynamics, airfoils and their characteristics. Horizontal Axis Wind Turbine (HAWT): Blade element theory, wake analysis. Vertical Axis Wind Turbine (VAWT): Aerodynamics, rotor design, power regulation, yaw system.

**Unit III** Selection of site. Mechanical and electrical applications. Wind farms: Interfacing, maintenance. Management of power generated by wind mill: Instruments and controls. Stand alone and grid connected systems. Wind energy storage. Wheeling and banking. Cost economics. Testing and certification procedures.

**Unit IV** Wind turbine loads: Aerodynamic loads in steady operation, wind turbulence, static. Wind energy control system (WECS). Synchronous and asynchronous generators. Annual Energy Output (AEO). Testing of WECS.

**Practical :** Visit to meteorological observatory. Wind velocity mapping and curve analysis. Wind energy instruments and resource assessment. Design of wind mills, water pumping wind mills. Performance evaluation of wind aero-generator. Wind turbine loads. Economics of wind energy systems.

**REE-506 Solar Photovoltaic System Design and Analysis** **1+1 Sem. II**

**Unit I** Physics of solar cells: Crystal structure, band theory, semiconductor, p-n junctions, absorption of radiation, generation, recombination and carrier separation. Standard solar cell structure: PVcharacteristics, conversion efficiency, losses in solar cell, impact of radiation and temperature.

**Unit II** Solar PV module technologies, First generation: Silicon wafer based technology, Second generation: Thin film technologies, Third generation/emerging PV technologies: Organic PV, Dye sensitized PV, Quantum-dot, Hot-carrier, up conversion and down conversion. Latest benchmark efficiencies: Laboratory and manufacturing. Fabrication technologies.

**Unit III** Solar PV systems: Balance of System (BoS), SPV system design guideline and methodologies, introduction to PV system, designing of standalone/grid connected PV systems for domestic/commercial use. Rooftop business models: CAPEX and RESCO, canal top, floating PV system design.

**Unit IV** Materials and devices for energy storage: Batteries, Carbon Nano-Tubes (CNT), fabrication of CNTs, CNT-polymer composites, ultra-capacitors etc.

**Practical :** Solar cell efficiency testing. SPV fabrication technologies. System integration and BoS matching studies. PV software's operation and utilization. Design and estimation of SPV systems components for agro based industrial applications. Batteries performance testing.

**REE-507 Renewable Energy Policy, Planning and Economics** **3+0 Sem. I**

**Unit I** Introduction to policy parameters, regulatory bodies. Introduction to overall policy environment on energy sector, policy formulation parameters. Entities: Consumers and their tariffs, generator, DISCOM, Regulators: CERC and SERC, Statutory bodies. Typical issues of Indian power sector.

**Unit II** Indian energy Policy: Introduction, Electricity Act, National Policy on Tariff, Climate Change, RE, Solar Missions, Wind Power and Regulatory Commissions. Concept of Grid Code, Green Corridor, Solar and Hybrid Parks. Electricity Trading: Open Access, RPO Distributed Generation Regional Grid Region. International Energy Policies and Treaties.

**Unit III** Policy and planning: Energy, environment interaction, clean development mechanism, financing of energy systems, software for energy planning, socio-economical approach. Project management in energy: Cost economics-sensitivity and risk analysis.

**Unit IV** Energy economics: economic evaluation of renewable energy systems, life cycle costing, components of energy investment and risk and uncertainties in energy investment.

**REE-508 Alternate Fuels and Applications** **2+1 Sem. II**

**Unit I** Introduction to alternate fuels: Methanol, ethanol, biogas, producer gas, hydrogen and fuel cell. Production composition and properties, combustion characteristics, comparison with conventional fuels, potential, possibilities and problems.

**Unit II** Fuel cell: Principle, classification, system efficiency. Life cycle assessment of fuel cell systems.

**Unit III** Hydrogen fuel: Production, gas clean up, challenges and opportunities. Hydrogen storage and energy economy.

**Unit IV** Utilization: Thermal and mechanical applications. Environmental impact and safety factors of alternate fuel, efficiency, economics and commercial considerations.

**Practical :** Performance of I.C. engines on alternate fuels, measurement of flue gas parameters, thermal applications of alternate fuels. Hydrogen production. Biomass based fuel cell. Integrated biomass based gasifier for power generation.

**REE-509 Biogas Technology and Mechanism** **1+1 Sem. I**

**Unit I** Biogas Technology: Potential and status, chemistry, physical conditions and utilization of alternate feedstock materials.

**Unit II** Types of reactors: Single phase, two phase processes. High rate bio-methanation process, selection of model and size, construction technique, material requirement. Design concept of night soil, kitchen waste, solid state cold condition biogas plants.

**Unit III** Biogas distribution and utilization: Properties and uses of biogas, design of gas distribution system. Biogas utilization devices: Biogas scrubbing and compressing, dual fuel engines and its limitations, generation of power. Testing of biogas appliances.

**Unit IV** Effluent: Handling of effluent biogas plant, effluent treatment and management, BDS applications and enrichment. Cost and financial viability of biogas plants. Repair and maintenance of biogas plants.

**Practical :** Design of biogas plant for solid and liquid wastes, cost estimation, analysis of biogas, purification of biogas. Performance evaluation of biogas appliances. Testing of biogas burner for heat transfer, thermal and cooking efficiency. Bio digested slurry analysis, use of biogas spent slurry. Carbon credits.

**REE-510 Energy, Ecology and Environment 3+0 Sem. II**

**Unit I** Global carbon cycle. Carbon reservoirs flow and human interventions. Global warming and climate change. Energy efficient technology: Efficiency hierarchy, energy dependent activities, energy policies, linkage between energy use and economic growth and environment.

**Unit II** Ecosystem: Kinds, transfection, components of ecosystem, ecosystem development of evaluation, major ecosystem of the world, physical environment and metrology.

**Unit III** Climate change: Impact and models. Energy for sustainable development: Development indices, pillars, subsystems, principles and dimensions. Low carbon technologies: Energy efficiency projects, carbon trading.

**Unit IV** Environment, Environmental degradation: Thermal and chemical pollution, primary and secondary pollutant, air pollution, water pollution, unclear energy hazard, radioactive hazards, mining hazards, land use, oil spills and gas leaks.

**Unit V** Global environmental changes: United Nations Framework Convention on Climate Change (UNFCC), Kyoto protocol and clean development mechanism: Overview, administration, participation, institutions, procedures, project design and formulation.

**REE-511 Design and Analysis of Renewable Energy Conversion Systems 2+1 Sem. I**

**Unit I** Energy cycle of the earth. Estimation and assessment of renewable energy sources: Water flow and storage, ocean currents and tides, biomass energy, solar energy, wind energy and other renewable energy sources.

**Unit II** Thermodynamics of renewable energy conversion: Energy and exergy analysis of renewable energy power systems. Optimum design of hybrid renewable energy systems: Concept, considerations and methodologies.

**Unit III** Design of renewable energy systems: Design concept, operational parameters, consideration and rational values for agro industrial applications.

**Unit IV** Performance analysis of renewable energy systems: Standards and test codes, optimum performance records, evaluation and maintenance aspects, uses of HOMER (Hybrid Optimization Model for Electric Renewable) software.

**Practical :** Estimation and assessment of renewable energy sources in India. Thermodynamic principles of energy conversion. Design and operational parameters of renewable energy systems. Study on standards and test codes of renewable energy systems.

**REE-512 Energy Generation from Agricultural Waste and By products 2+1 Sem. II**

**Unit I** By Products: Generation, estimation and utilization. Agricultural and agro industrial by products/wastes: Properties, characterization, on site handling, storage and processing. Concept, scope and maintenance of waste management and effluent treatment

**Unit II** Waste as fuel: Utilization pattern, pre-treatments, secondary treatments, mechanism, construction, efficiency and suitability.

**Unit III** Utilization of agro based industrial wastes for paper production, production of particle board, fertilizer through vermi-composting and fuel.

**Unit IV** Thermo-chemical and biochemical conversion of agricultural waste and by products: Densification, combustion, gasification, extraction, pyrolysis, carbonization, torrefaction, liquefaction, anaerobic digestion and fermentation process.

**Practical :** Estimation and characterization of agricultural waste and by products, production of fuel from agricultural wastes and by products, techno-economic feasibility of waste to fuel systems.

**REE-513 Agro Energy Audit and Management** **2+1** **Sem. I**

**Unit I** Energy resources on the farm: Conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products. Pattern of energy consumption and their constraints in production of agriculture.

**Unit II** Direct and indirect energy, energy audit of production agriculture, rural living and scope of conservation.

**Unit III** Energy requirement in different agro-based industries: Energy analysis, energy ratio and specific energy value. Identification of energy efficient machinery systems: energy losses and their management.

**Unit IV** Energy analysis techniques and methods: Energy balance, output and input ratio, resource utilization, conservation of energy sources. Energy conservation planning and practices.

**Practical :** Study of energy audit techniques, energy use pattern and management strategies in various agro-industries, assessment of overall energy consumption, production and its cost in selected agro-industries. Estimation of energy requirement in different agriculture production system, study of energy input/output ratio of different agriculture production system.

**REE-514 Green House Energetic and Passive Architecture** **1+1** **Sem. II**

**Unit I** Green House: Environmental requirement, analysis of thermal energy flows, analysis of a greenhouse as solar collector. Instrumentation and control in green house.

**Unit II** Passive concepts and components: Passive heating concepts, direct gain, indirect grain, isolated gains and sunspace passive cooling concepts,

**Unit III** Evaporative cooling: Evaporative air and water coolers, application of wind, water and earth for cooling, use of isolation, shading, paint sand cavity walls for cooling.

**Unit IV** Passive heating and cooling: Concepts, roof pond/sky thermo, roof radiation trap, vary thermo wall, earth sheltered or earth based structures and earth air tunnels, ventilation, components, windows and thermal storage.

**Practical :** Design of passive structures for animals, rural housing, study of evaporative cooling, air and light flows in house, survey of green houses, green house energetic.

**REE-515 Energy Management in Food Processing Industries** **1+1** **Sem. I**

**Unit I** Energy forms and units, energy perspective, norms and scenario, energy auditing, data collection and analysis for energy conservation in food processing industries.

**Unit II** Sources of energy, its audit and management in various operational units of the agro-processing units, passive heating, passive cooling, sun drying and use of solar energy, biomass energy and other non-conventional energy sources in agro-processing industries.

**Unit III** Reuse and calculation of used steam, hot water, chimney gases and cascading of energy sources. Energy accounting methods, measurement of energy, design of computer-based energy management systems, economics of energy use.

**Practical :** Study of energy use pattern in various processing units i.e., rice mills, sugar mills, dal mills, oil mills, cotton-ginning units, milk plants, food industries etc. Energy audit study and management strategies in food processing plants. Identification of energy efficient processing machines. Assessment of overall energy consumption, production and its cost in food processing plants, visit to related food processing industry.

## Ph.D. courses

**REE-601 Biochemical Conversion of Biomass** **2+1** **Sem. I**

**Unit I** Biomass formation: Energy recovery and recycling. Biochemical conversion of organic wastes: Methane production, vertical through digesters, high solid digestion, sludge treatment.

**Unit II** Lagoons: Composting, contact and filter digestion, reactors, physical and chemical removal of dissolved materials. Activated sludge and other suspended culture process parameters. Waste waters, biological film flow processes, sanitation land fill, pre-digestion of waste.

**Unit III** Engineering design of biogas units: Biogas boosters, structural behaviour, alternate construction materials, multi-criteria optimization, immobilization, modular biogas for tropical areas, kinetic models.

**Unit IV** Bioconversion of biomass to alcohol: Types and pre-treatment of biomass, production process. Fermenter design and process parameters. Economics of bio-alcohol production, reaction kinetics, gasohol. Bio-hydrogen from algae/biomass.

**Practical :** Lagoons and compositing. Biogas plant: Analysis of biogas system. Determination of methane production rate and parameters, biogas storage, purification, utilization and kinetic equations. Alcohol production, optimization of process parameters, fermenter designing and evaluation. Economic calculations of biogas and alcohol.

**REE-602 Thermo-Chemical Conversion of Biomass** **2+1** **Sem. II**

**Unit I** Biomass: Characterization, resources and energy recovery. Thermo-chemical conversion of organic wastes. Chemical thermodynamics, stoichiometry and thermodynamics.

**Unit II** Combustion of fuels: Solid fuels, stoker, types, fluidized bed. Liquid fuels: Atomization, vapour concentration, combustion phenomena. Gaseous fuel: Flame characteristics, inflammability limits, submerged combustion, combustion with explosion flame, pulsating combustion.

**Unit III** Biomass Gasification: Gasifier configurations, classification, entrained flow, fluidized bed, moving bed, plasma gasification. Coal gasification technologies. Syngas characteristics. Tar and particulates in gasification. Integrated coal gasification. Gas turbine technologies.

**Unit IV** Pyrolysis: Models, regimes, kinetics and effect of process parameters. Radiant heat flux, heterogeneous reactions, wall heat transfer. Fluidized bed reactors: Heat transfer circulating beds, moving bed reactor.

**Unit V** Torrefaction and charcoal production: Carbonization parameters, temperature zone, input output, energy density ratios and characterization of finished products.

**Practical :** Combustion thermodynamics and phenomenon in solid, liquid and gaseous fuels. TGA studies. Liquid and gaseous burners, flame studies, flue gas, heat budgeting. Kinetic study on gasifiers. Producer gas based power generation systems. Kinetic and model studies for torrefaction, char coal and bio oil production.

**REE-603 Advances in Renewable Energy Systems** **2+1** **Sem. I**

**Unit I** Solar thermal energy systems: Kinetics and heat transfer analysis, modeling studies. Design and performance of solar thermal systems, mathematical models, power plants, design and performance.

**Unit II** Photovoltaics: Thermodynamic limitations of photocells. Semiconductors: P-n and n-p junctions, module design, sizing, power control and storage, space charge control, low pressure diode, cesium converter. Photo electro chemical cells, photo electrolysis cell.

**Unit III** Wind power: Rotor design procedure, betz limit, ideal horizontal axis wind turbine, wake rotation, momentum theory and blade element theory, blade shape for ideal rotor without wake rotation, performance prediction wind turbine rotor dynamics and dynamic models.

**Unit IV** Designing of water pumping wind mills: Electric power, power transformers, electrical machines, ancillary electrical equipment, wind power to consumer/grid. Wind turbine: Sitting, installation and operation issues, offshore wind farms, operation in severe climates.

**Practical :** Design parameters of air collectors. Thermal analysis and heat loss, regularity models of heliostatic fields, power plant design. Photovoltaic cells characteristic curves. Water pumping. Power control system, grid control devices. Design of wind mills, rotor design procedure, momentum theory and blade element theory. Wind mill installation and operation issues.

**REE-604 New Alternate Energy Systems** **2+1** **Sem. II**

**Unit I** Hydrogen production: Water splitting, electrolytic methods, chemical cycle, photo splitting, photo galvanic, photo chemical. Hydrogen storage and utilization. Fuel cells: Reactions, types, design, applications, conversion and problems. Thermoelectric convertor and thermionic convertors. Magneto hydra dynamic system (MHD). Electro gas dynamics (EGD): Principles, types.

**Unit II** Tidal energy: Operating mode, energy content. Estimation of wave power, tidal power sites and ocean thermal energy cycle (OTEC): Baseline design, heat design, power cycle design, plant working.

**Unit III** Geothermal energy system: Classification, binary cycle conversion, waterfed heat pumps, electric generation, steam generation, steam field. Heat mining, Darcy's law, volcano related heat resources, sedimentary basins, hot dry rocks.

**Unit IV** Power generation through alternative sources. Environmental pollution: Measurements and control methods, instrumentation, pollution standards, social cost estimates, $CO_2$ reduction potential, $CO_2$ sequestration.

**Practical :** Testing of electrolysis plant, photo electric plant, photo plant, design criteria of fuel cell. Design considerations for alternative energy systems.

**REE-605 Fuels and Combustion** **2+1** **Sem. I**

**Unit I** Solid and liquid fuels: Type and availability, oxidation, hydrogenation of solid fuel and processing of solid fuels. Liquid Fuels: Processing, properties testing of liquid fuels and refining. Liquid fuels from other sources: Preparation and storage. Production technologies for solid and liquid fuel.

**Unit II** Gaseous Fuels: Types, processing and testing of gaseous fuels, gases from biomass refinery gases, LPG, oil gasification, cleaning and purification of gaseous fuels. Gaseous fuel production technologies.

**Unit III** Combustion Stoichiometry: Thermodynamics and kinetics, solid, liquid and gaseous fuels. Combustion of solid fuels. Biomass combustion, stages of wood combustion, industrial biomass combustion concepts, types of combustion system.

**Unit IV** Combustion of liquid fuels: Atomization, vapor concentration, droplet and ignition. Liquid fuel burners: Atomizing air burners, pressure jet atomizing burners, thin fluid burners, rotary atomizing burners.

**Unit V** Combustion of gaseous fuel: Character, shape and size of the flame. Flame stabilization of bluff bodies. Effect of equivalence on reaction rate and extinction velocity, submerged combustion, combustion with explosion flame, pulsating combustion.

**Practical :** Determination of fuel properties of solid, liquid and gaseous fuels. Determination of efficiency of combustion system using solid, liquid and gaseous fuel. Standard testing of burners for thermal efficiency for solid, liquid and gaseous fuel.

**REE-606 Advances in Biogas Technology** **2+1** **Sem. II**

**Unit I** Worldwide review of anaerobic digesters, realistic potential of biogas, analysis of biogas system and proposed means for their prospects. Engineering design of biogas units for biogas production from solid and liquid wastes.

**Unit II** Design parameters: Affecting and failure of biogas systems, structural behaviour and conditions of fixed dome digesters, alternate construction materials, gas holders for gas production in colder regions, heating, stirring etc.

**Unit III** Multi-criteria optimization design of fermentation systems, immobilization, modular biogas for tropical rural areas. Toxicity effect of pesticides herbicides on the anaerobic digestion process. Kinetic models, design equations, contact and anaerobic filter digesters, high rate digesters.

**Unit IV** Scrubbing, purification and compression of biogas. Scaling-up and standardization of biogas plant for power generation and heating. Advanced biofuels: Bio-CNG/renewable natural gas (RNG) as vehicle fuel. Liquefaction of biogas.

**Practical :** Engineering design and analysis of biogas system. Development of kinetic equations. Biogas purification, compression and liquefaction. Industrial applications of biogas.

**REE-607 Solid Waste and Wastewater Management 2+1 Sem. I**

**Unit I** Solid waste: Sources, quality, classification and characteristics, collection and reduction at source, handling, storage, transportation and disposal methods.

**Unit II** Reactor for anaerobic digestion: Contact and filter digestion, homogenous and non-homogeneous reactors. Energetic and kinetics of anaerobic treatment.

**Unit III** Gas transfer, mass models, bubble aeration, film flow oxygen transfer, stripping, solids removal. Activated sludge and other suspended culture processes parameters. Biosorption of contact stabilization.

**Unit IV** Sanitation land fill, municipal and compost treatment. Pre-digestion of waste. Sensors, ICT and remote sensing technologies for waste management.

**Practical :** Design principles in waste treatment, equipment specification and instrumentation. Mathematical modeling of BOD and COD reduction rate, recovery by batch distillation.

**REE-608 Advanced Photovoltaic Power Generation 1+1 Sem. II**

**Unit I** Semiconductors: Transport properties, junctions, dark and illumination characteristics. Single junction and multi junction films. Solar PV concentrator cells and systems. Thin film solar cells: Nano, micro, and polycrystalline solar cells.

**Unit II** Systems for remote applications and large solar PV power plants: System integrations, roof top system, sizing methodology, power control, storage, tracking and control. PCID simulation of industrial solar cell structure, software's in solar cell simulation.

**Unit III** Space charge control, low pressure diode, MMPT, cesium converter, system considerations. Photo electro chemical cells and materials. Photo galvanic cells: Recent development.

**Unit IV** Conjunctive use of photo conversion systems: Photo-agriculture system, components, integration and economics. Software's for PV system integration and designing. PV system for ground mounted and rooftop plants with shadow analysis.

**Practical :** PV systems for typical applications, water pumping, solar PV tracking and mechanical clock tracking. Testing of power control system for output regulation, charging and discharging characteristics of storage by PV panels.

**REE-609 Energy Planning, Management and Economics 3+0 Sem. I**

**Unit I** Energy resources on the farm: Conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products. Pattern of energy consumption and their constraints in production of agriculture. Direct and indirect energy.

**Unit II** Energy audit of production agriculture and rural living and scope of conservation. Identification of energy efficient machinery systems, energy losses and their management.

**Unit III** Energy analysis techniques and methods: Energy balance, output and input ratio, resource utilization, conservation of energy sources. Energy conservation planning and practices.

**Unit IV** Energy forecasting, energy economics, energy pricing and incentives for energy conservation, factors effecting energy economics. Techno-economic evaluation of RET's, computation of programme for efficient energy management.

**REE-610 Renewable Energy for Industrial Application** **2+1** **Sem. II**

**Unit I** Elucidation of unit operations in industry. Energy quantification techniques, system boundary, estimation of productivity, plant capacity utilization, energy density ratio and energy consumption pattern. Energy flow diagram conservation opportunities identification.

**Unit II** Solar energy for industrial application: Solar water heating, steam solar cooking system, industrial solar dryer and solar process heat, solar cooling system (refrigeration, air conditioning and solar architecture technology), solar furnace and solar greenhouse technology for high-tech cultivation. Solar photovoltaic technology for industrial power.

**Unit III** Bio energy for industrial application: Quantification of industrial bio-waste, characterization, power generation through bio-methanation, gasification and dendro thermal power plant.

**Unit IV** Wind energy: Aero generator of new era and national and international state of art in wind power generation. Other renewable energy sources: Magneto hydro dynamics, fuel cells technology and micro-hydro energy technology.

**Practical :** Elucidation and energy consumption for unit operations in industry. Study of energy quantification and identification of opportunities for RET's. Design of solar dryers. Design of solar photovoltaic system. Design of gasifiers for thermal energy and power generation. Design of combustor (gasifier stove). Study of solar greenhouse. Study of biogas engine generator set. Case study of agro-industrial energy estimation and visit to RSE power generation site.

**REE-611 Biofuel Technologies and Applications** **1+1** **Sem. I**

**Unit I** Liquid biofuels: Non-edible oilseeds, oil extraction, pre-processing, characterization. World scenario: Liquid fuel challenges and some solutions. Liquid bio-fuel applications.

**Unit II** Bioethanol: First and second generation ethanol production technologies. Production of syngas from biomass, production of methanol from syngas, production of ethanol from lingo-cellulosic biomass. Syngas and poly-generation, chemical conversion of syngas to methanol and ethanol and some advanced fuels like bio butanol, bio-propanol.

**Unit III** BioCNG: Biogas to green vehicle fuel, anaerobic digestion. Bio gas opportunities: Landfill gas, agricultural and industrial wastewater and additional sources of methane.

**Unit IV** Biodiesel: Feedstock for biodiesel, manufacturing processes for biodiesel, value addition by utilization of by-products, environmental impacts of biodiesel, biodiesel from algae, biodiesel engines.

**Unit V** Pyrolysis oil: Fast pyrolysis technologies, composition and issues of bio oil. Bio oil upgradation technologies.

**Practical :** Evaluation of liquid fuel system for heat and power generation and characterization of liquid fuel, transesterification process. Engine performance on biodiesel. Biogas-engine system for transport vehicle. Bio oil production by pyrolysis.

**REE-612 Energy Modeling and Simulation** **1+1** **Sem. II**

**Unit I** Model: Basics, system, boundary, interaction, types of models, physical, analogy models and applications. Mathematical models: Concepts, input, output model, stochastic, deterministic, empirical models, linear, non-linear models, interdependence of energy, economy, environment, modeling concept and application.

**Unit II** Energy Modeling: Review of various energy sector models, energy demand analysis and forecasting, energy supply assessment and evaluation, energy demand, supply balancing, energy modeling in the context of climate change.

**Unit III** Model studies in gasification, pyrolysis, biogas, fermentation, biodiesel, solar, wind technologies and heat transfer applications. Moving boundary models.

**Unit IV** Energy economics of energy sources: Investment and cost management in various energy technologies. Economics of energy generation, energy conservation economics, financial analysis, sensitivity and risk analysis.

**Practical :** Formulating dimensionless numbers, applications, types of models, mathematical model formulation and types, Software's and model evaluation. Development of models in thermo-chemical and biochemical conversion processes. Studies on model development in solar and wind technologies, economics of energy generation and conservation, financial analysis.

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|---|---|
| **REE-691 Seminar I** | **1+0** |
| **REE-692 Seminar II** | **1+0** |
| **REE-699 Ph.D Research** | **0+75** |

# ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY

## ELECTRICAL ENGINEERING

## PROGRAMMES

**M. Tech.**

**Ph. D.**

## COURSE REQUIREMENTS

### M. Tech.

| | |
|---|---|
| Field of Specialization | Electrical Engineering |
| Required Courses | EE-501, EE-503, EE-509 |
| Supporting Courses | Stat.-502, or courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem can be taken as per recommendation of the student's advisory committee. |
| Minor Field | Courses from the discipline of Computer Science & Engineering /Information Technology/ Maths & Stat or any other course(s) from any other department can be taken as per recommendation of the student's advisory committee. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

### Ph. D.

| | |
|---|---|
| Field of Specialization | Electrical Engineering |
| Required Courses | EE-601 |
| Supporting Courses | Courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem can be taken as per recommendation of the student's advisory committee. |
| Minor Field | Courses from the discipline of Computer Science & Engineering / Information Technology/ Maths & Stat or any other course(s) from any other department can be taken as per recommendation of the student's advisory committee. |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**EE 101 Electrical Engineering** **2+1** **Sem. I**

**(For students of College of Agriculture)**

AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, reluctance etc, laws of magnetic circuits, Phase relations and vector representation, AC through resistance, inductance and capacitance, A.C. series and parallel circuits, Simple R-L, R-C and R-L-C circuits, 3 Phase Systems: Star and Delta connections, Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement. Transformer : Principle of working, construction of single phase transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test. Single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors. Poly-phase induction motor: Construction, operation, equivalent circuit, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, D.C. Machine (generator and motor): Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics, D.C. Motors, their starting, speed controls and characteristics.

**Practical:** Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of Power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, Starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor-determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor.

**EE 204 Electrical Machines and Power Utilization** **2+1** **Sem. I**

Various methods of three phase power measurement. Power factor, reactive and apparent power, Concept and analysis of balanced poly-phase circuits. Series and parallel resonance. Electromotive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses. Transformer: principle of working, construction of single phase transformer, emf equation, phasor diagram on load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests. Principle, operation and performance of DC machine (generator and motor), emf and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics. DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control. Poly-phase induction motor: construction, operation, phasor diagram, effect of rotor resistance, torque equation, condition for maximum torque, starting and speed control methods. Single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors and fractional horsepower motors.

**Practical:** To obtain load characteristics of DC shunt, series, compound generator. To study characteristics of DC shunt/series motors. To study DC motor starters. To perform load-test on 3-phase induction motor and plot torque-speed characteristics. To perform no-load and blocked–rotor tests on 3-phase induction motor to obtain equivalent circuit parameters & to draw circle diagram. To study the speed control of 3-phase induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor. To study star-delta starters physically and(a) to draw electrical connection diagram (b) to start the 3-phase induction motor using it (c) to reverse the direction of 3-phase induction motor. To start a 3-phase slip–ring induction motor by inserting different levels of resistance in the rotor circuit

and plot its torque–speed characteristics. To perform no load & blocked–rotor test on single phase induction motor and determine the parameters of equivalent circuit drawn on the basis of double revolving field theory. To perform load–test on single phase induction motor and plot torque-speed characteristics. To study power consumed in a 3-phasecircuit. Two lamps in series controlled by one switch. Two lamps in parallel controlled by one switch.

**EE 206 Electronics and Instrumentation** **2+1** **Sem. II**

**(For students of College of Agriculture Engineering & Technology and College of Agriculture)**

Semiconductors. P-N junction. V-I characteristics of P-N junction. Diode as a circuit element: rectifier, clipper, clamper, voltage multiplier, filter circuits, diode circuits for OR and gates (both positive and negative logic). Bipolar junction transistor, operating point, classification (A, B and C) of amplifier, characteristics of common emitter NPN transistor, various biasing methods (fixed, self, potential divider bias). Coupling of amplifiers, h-parameter model of a transistor: Analysis of small signal Common Emitter amplifier, analysis of differential amplifier using transistor. Ideal Operational Amplifier characteristics, linear and non-linear applications of OP-AMP as adder, subtractor, integrator, active rectifier, comparator, differentiator, differential amplifier, instrumentation amplifier and oscillator. Zener diode as voltage regulator. Transistor series regulator: Current limiting, OP-AMP voltage regulator. Basic theorems of Boolean algebra. Combinational logic circuits (basic gates, Sum of Product rule and K-map). Binary ladder D/A converter, successive approximation A/D converter. Generalized instrumentation system. Measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples, Bourden tube, LVDT, Strain gauge and tacho-generator.

**Practical**: Study of diode characteristics. Study of Zener diode. Study of V-I characteristics of P-N junction diode. Study of RC coupled amplifier. Study of full wave rectifier. Verification of logic gates. Determination of energy gap in a junction diode. Study of transistor characteristics in CE configuration. Study of OP-AMP IC 741 as differential amplifier. Study of half wave rectifier. Study of OP-AMP IC 741 as active rectifier, inverting and non- inverting amplifier, differentiator, integrator and comparator. Study of transistor characteristics. Study of temperature characteristics of resistor. Study of diode as clipper and clamper.

**EE Instrumentation and Process Control in Food Industry** **2+1** **Sem. II**

Introduction, definitions, characteristics of instruments. Temperature and temperature scales. Various types of thermometers: thermocouples, resistance thermometers and pyrometers. Pressure and pressure scales, manometers, pressure elements, differential pressure. Liquid level measurement. Flow measurement: kinds of flow, rate of flow, total flow. Variable area meters, food flow metering. Weight measurement: mechanical scale, electronic tank scale, conveyor scale. Measurement of moisture content, specific gravity, humidity, viscosity, turbidity, color, density, brix, pH. Enzyme sensors, automatic valves. Transmission: pneumatic, control elements, control actions, pneumatic control systems. Process control: definition, simple system analysis. Transducers: classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices. Controllers and indicators: temperature control, electronic controllers, flow ratio control, atmosphere control, timers and indicators, food sorting and grading control. Introduction to controllers, computer-based monitoring and control, examples in food processing.

**Practical:** Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer.

## Postgraduate Courses

**EE-501 Programmable Logic Devices & Controllers** **2+1** **Sem. I,II**

**Unit I** Introduction to Programmable Logic Devices (PLD), Classification of PLDs, Applications of Programmable Logic Devices, Introduction to PLC, Concept of PLC, Building blocks of PLC, Functions of various blocks, limitations of relays. Advantages of PLCs over electromagnetic relays.

**Unit II** Different programming languages, PLC manufacturer etc, Basic operation and principles of PLC - Scan Cycle - Memory structures, I/O structure - Programming terminal, Power supply, Basic instructions like latch, Master control self-holding relays.

**Unit III** Timer instruction like retentive timers, resetting of timers - Counter instructions like up counter, down counter, resetting of counters.

**Unit IV** Arithmetic Instructions (ADD,SUB,DIV,MUL etc.) - MOV instruction - RTC(Real Time Clock Function) - Watch Dug Timer - Comparison instructions like equal, not equal, greater, greater than equal, less than, less than equal, Ladder Diagram Programming.

**Practical :** Components/sub-components of a PLC, Learning functions of different modules of a PLC system, Practical steps in programming a PLC (a) Using a Hand held programmer (b) Using computer interface, Introduction to programming language, ladder diagram concepts, Basic logic operations, AND, OR, NOT functions, Logic control systems with time response as applied to clamping operation, Sequence control system e.g. in lifting a device for packaging and counting. Use of PLC for an application.

**EE-502 Design and Application of Transducers** **2+1** **Sem. I**

**Unit I** Introduction to functional elements of an instrument, active and passive transducers, analog and digital modes, null and deflection methods, performance characteristics of instruments including static and dynamic characteristics.

**Unit II** Measuring devices for force, torque and shaft power, strain gauge type devices and their design and application in two and three dimensional force measurement. Design and analysis of strain gauge type tillage toll dynamometers. Devices for measurement of temperature, pressure, sound, vibration, flow.

**Unit III** Measuring instruments for calorific values of solid, liquid and gaseous fuels. Measurement of gas composition using GLC. Computer based data acquisition system.

**Practical :** Calibration of instruments, measurement of strain, making of thermocouples and their testing, flow measurement in a pipe, humidity measurement, data acquisition analysis and interpretation, signal conditioning circuits, testing of pressure transducers.

**EE-503 Instrumentation Engineering** **2+1** **Sem. I,II**

**Unit I** Review of Primary Sensing Elements and Transducers, Signal Conditioning: Instrumentation amplifiers.

**Unit II** Low-level DC/AC amplifiers. Filters: Low pass, High pass, Band Pass, Band Reject, Active Filters; Bridge Circuits, attenuators, compensators and discriminators, Integrators and differentiators, Function generators, A/D and D/A converters.

**Unit III** Resolution and Quantization, Sampling, Signal transmission: Data Transmission & telemetry: Modulation Techniques, TDM, FDM, Bandwidth and Noise Restrictions. Digital displays, recorders. Power supplies, SMPS.

**Unit IV** Data acquisition systems, Review of 8085 Microprocessor/ 8051 microcontroller and Microprocessor /Microcontroller- based instrumentation systems.

**Practical :** Application of instrumentation amplifiers, filters and other signal processing circuits. Applications of A/D and D/A convertors, Study of Modulation Techniques, Experiments on interfacing transducers to microcomputers/ Microcontroller/ Microprocessors.

**EE-504/ CSE-507 Process Control System** **2+1** **Sem. I**

**Unit I** Introduction to Process Control - Control strategy, single variable and multi variable control systems, Process Control loop, Open loop and closed loop control system, Linear and non-linear control system.

**Unit II** Determining the Transfer function of Complex Control System, Representation of a Control System by block diagram and its Reduction Characteristics. Process Equation. Controlling and Controlled Variable. Transient & steady state response, Self-Regulation Property

**Unit III** Control System Parameters, Evaluation of control System. Controller Modes or actions - ON/ OFF Mode, Proportional Mode, Integral Mode, Derivative Mode, Composite control Modes. Pressure regulation, Liquid level and Temperature control Systems. Signal Conditioning.

**Unit IV** Design of OP AMPS circuits used to implement Proportional, Integral, Derivative and Composite Modes. Introduction to computer control of process. Applications and design.

**Practical :** Study of performance of thermister, LVDT, thermocouple, strain gauge; open loop control systems, feedback control system; PI, PD, PID Controller; Simulation of typical control systems; use of microprocessors in process control.

**EE-505 Applied Instrumentation** **2+1** **Sem. II**

**Unit I** Transducer principles. Displacement Transducers- Potentiometer, LVDT, Piezoelectric and Capacitive transducers, digital transducers. Velocity transducers - Analog and Digital. Acceleration and Force transducer.

**Unit II** Torque, Power and Energy measuring techniques. Temperature measurement using Bi-metals, PTRs, Thermisters, Thermocouples, Electronic IC sensors and Pyrometers. Heat flux and Humidity measurement, Soil and Grain moisture transducers.

**Unit III** Pressure measurement - Manometers, Bourdon Tube, Diaphragm, high pressure and vacuum sensing techniques. Flow transducers- Venturimeter, Rotameter, Drag force, Ultrasonic, Electromagnetic, Hot wire anemometers. Time, Frequency, Level measurement.

**Unit IV** Optical Density and pH measurement, pCO2 and grain quality measurement. Biomedical measurement - BP, Heart Rate, ECG, Ultrasonic flaw detection. Spectroscopy.

**Practical :** Laboratory exercises to demonstrate applications of displacement, pressure, velocity temperature, moisture, humidity, heat flux, flow, ultrasonic and biomedical transducers.

**EE-506 Drone Technology** **2+1** **Sem. I**

**Unit I** Familiarization of different components, parts, block of the drone and its function & their interconnectivity, Classification of various body material used in drone.

**Unit II** Recognize basic principles of flying like Bernoulli's Principle etc. Recognize multi rotor design, various configurations, airframe sizes and construction materials. Identify different propeller designs and design using 3D printer. Identify different types of motor used in drone.

**Unit III** Identify & prepare specific flight planning procedures to drone flights, Identification of different types of SMD Components and measure their value using SMD Technology Kit, Identify and use SMD soldering and de-soldering rework station, Identify and use different functions of measuring instruments for different measurements of electrical parameters. Measurement of voltage dc & ac using Digital Multimeter.

**Unit IV** Measurement of current dc & ac using Digital Multimeter Measurement of frequency using Digital Multimeter Measurement of peak to peak voltage, frequency, time period, and duty cycle using DSO and waveform generator. Measurement of analog & digital signal using DSO. Measurement of unknown frequency and it's level using spectrum analyzer, Identification of different type of batteries Li-ion and Li-Po. Recognize different battery specifications.

**Practical :** Explore different charging techniques to charge batteries. Battery management to measure and monitor different parameters of different batteries. Inspect battery packs for bulges or leakage. Inspect charger for visible damage and perform voltage and current reading of battery. Explore Battery power management includes functions for charging, monitoring, and charge protection.

**EE-507/ CSE-518 Microcontroller and Embedded systems** **2+1** **Sem. II**

**Unit I** Microprocessor: Architecture, Register Organization, Programming Model, Memory Segmentation, Addressing modes, Instruction Set.

**Unit II** Microcontroller: Architecture, I/O Ports, Memory Organization, Instruction set, Brief overview of real time systems and embedded systems –

**Unit III** Classification of embedded systems -Embedded system definitions - Functional and non-functional requirements - Architectures and standards - Core of the embedded system, Sensors and actuators.

**Practical :** Hands-on experience in the use of microcontroller system and design of peripheral controllers and interfaces along with construction and debugging of IC circuits.

**EE-508 Linear System Analysis** **2+0** **Sem. II**

**Unit I** Review of linear algebra. Laplace transformation, Laplace Transform theorems, Inverse Laplace Transformation, Solution of Linear differential equations by Laplace transform Methods, Discrete Time system and the Z-transform Methods, Z-transforms.

**Unit II** Mathematical Models of Physical Systems. Use of graph theory, linearization. Transient and Steady State Response analysis. Stability. Controllability and Observability. State estimation. Computer aided solutions.

**EE-509 Methods of Optimization** **2+1** **Sem. I,II**

**Unit I** Parameter optimization. Linear programming, Application of Linear Programming Methods Formulation of LPPs, Solutions of LPP: Graphical, Simplex Method, Big M Method, 2- Phase Method. Duality in Linear programming, Dual Simplex Method.

**Unit II** Integer programming, Sensitivity analysis. Network analysis in project planning - CPM, PERT, application of Network techniques, cost analysis and crashing of Network. Transportation problems. Assignment problems.

**Unit III** Dynamic programming: Approach, Formulation and solution. Direct search methods. Gradient methods. Optimization under uncertainty and risk. Evolutionary Algorithms

**Practical :** Unrestricted search methods, Newton Methods, Quasi Newton and Secant methods, Univariate methods, Direct and indirect search methods, Optimization of function of one variable and multiple variables; Gradient vectors, Use of software for solving linear optimization problems using graphical and simplex methods, Computational Discrete versus continuous dynamic programming.

**EE-510 Optimal Control** **2+1** **Sem. I**

**Unit I** Introduction to classical and modern control: optimization, optimal control; calculus of variations and optimal control: basic concepts, optimum of a function and a functional, the basic variational problem, the second variation, extrema of functions and functionals with conditions, variational approach to optimal systems.

**Unit II** Linear quadratic optimal control systems: problem formulation, finite-time linear quadratic regulator(LQR), analytical solution to the matrix differential Riccati equation, infinite-time lqr system , linear quadratic tracking system: finite-time case, lqt system: infinite-time case, fixed-end-point regulator system.

**Unit III** Frequency-domain interpretation; discrete-time optimal control systems: variational calculus for discrete-time systems, discrete-time optimal control systems, discrete-time linear state regulator systems, steady-state regulator system, discrete-time linear quadratic tracking system, frequency domain interpretation; pontryagin minimum principle: constrained systems, pontryagin minimum principle.

**Unit IV** Dynamic programming, Hamilton- jacobi-bellman equation; Constrained optimal control systems: Constrained optimal control, toc of a double integral system, LTI system, Energy-optimal control systems, Optimal control systems with state constraints.

**Practical :** Hands-on experience in the use of Non-linear optimizations MATLAB simulations will provide basic and advanced insights for optimal control system.

**EE-511 Maintenance Management** **2+0** **Sem. I**

**Unit I** Reliability: hazard rate, mean time between failures. System reliability: series, parallel and mixed configurations. Economics of introducing a standby or redundancy into a production system.

**Unit II** Maintainability. Replacement decisions: age replacement policy, replacement policies to minimize downtime, economics of preventive maintenance.

**Unit III** Inspection decision: optimal inspection frequency for profit maximization, minimization of downtime and availability maximization. Overhaul and repair decisions. Optimal overhaul/ repair/replace maintenance policies for equipment subject to breakdown. Spares provisioning.

**EE-512/ CSE-513 Internet of Things** **2+1** **Sem. I,II**

**Unit I** Introduction to IoT and its working, Difference between Embedded device and IoT device; Properties of IoT device; IoT Decision Framework; IoT Solution Architecture Models; Understand Sensing actions; Understand Actuators and Microelectromechanical Systems.

**Unit II** Communication Protocols used in IoT: Types of wireless communication; Major wireless Short-range communication devices; properties; comparison of these devices (Bluetooth, Wireless Fidelity (WiFi), Major wireless Long-range communication devices; properties;

**Unit III** IoT Applications: Industrial Internet; Applications such as: Smart Homes; Wearables; Smart City; Smart Grids; Connected Car; Connected digital health; telehealth; telemedicine; smart retail.

**Unit IV** Sensors: Applications of various sensors: Google Maps; Global positioning sensors: Global Positioning System; Global Navigation Satellite System; Indian Regional Navigation Satellite System; Galileo and indoor localization systems; Motion & Orientation Sensors: Accelerometer; Magnetometer; Proximity Sensor; Gyroscope.

**Practical :** Use of Open source to develop IOT devices. Design and build systems that will use sensors; communication protocols and actuators.

**EE-513/ CSE-519 Wireless Sensor Networks** **1+1** **Sem. I**

**Unit I** INTRODUCTION: Motivation for a Network of Wireless Sensor Nodes – Definitions and Background, Challenges and constraints; Applications of wireless sensor networks.

**Unit II** PHYSICAL LAYER: Basic Components, Source Encoding, Channel Encoding, Modulation, Signal Propagation, MEDIUM ACCESS CONTROL: Overview, Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols.

**Unit III** Contention-Based MAC Protocols, Hybrid MAC Protocols, POWER MANAGEMENT: Local Power Management Aspects, Dynamic Power Management, Conceptual Architecture.

**Unit IV** TIME SYNCHRONIZATION: Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols.

**Unit V** LOCALIZATION: Overview, Ranging Techniques, Range-Based Localization, Range-Free Localization.

**Practical :** Implement simulation experiments and projects based on Physical layer, network layer, transport layer, application layer and MAC layer of wireless sensor network.

**EE-591 Seminar** **1+0**

**EE-599 Master's Research** **0+30**

## Ph.D. courses

**EE-601 Analysis and Design of Instrumentation Systems** **2+1** **Sem. I,II**

**Unit I** General configuration and functional description of measuring systems. Signal flow graphs and block diagram reduction.

**Unit II** Dynamic characteristics of instrumentation systems. Operational transfer functions. Error constants and sensitivity. Frequency and transient response.

**Unit III** Stability criteria. Nyquist, Root locus and Bode analysis and design. Principles of stochastic methods in instrumentation design. Sample data systems analysis.

**Practical :** Determination of dynamic characteristics of instrumentation systems.

**EE-602 Non-linear and Time Varying Systems** **3+0** **Sem. I**

**Unit I** Non-linear systems and their analysis by linearization, describing function, piece-wise linear, phase plane: Delta Method and perturbation methods;

**Unit II** Methods of constructing trajectories and obtaining time solution from Phase Plane plots; Numerical solution of ordinary differential equations- Bisection Method, Newton Raphson method, Gauss Jordon method, Cayley Hamilton Theorem

**Unit III** Stability of non-linear systems: Kiosovskii Method, Variable Gradient method. Saturation, dead zone and time delay. Time varying systems and their analysis.

**EE-603 Large Scale Systems** **3+0** **Sem. II**

**Unit I** Review of graph theory - Graph, weighted Graph or network, Cyclic Graph, Drag, Warshall's Algorithm, Shortest path Algorithm,Link

**Unit II** Representation of Graph, Dijkastra Algorithm, Graph Traversal: Depth First and Breadth First; Spanning Forests, Symmetrical Directed, Connected Graphs, Minimum Spanning Trees.

**Unit III** Large scale system modeling. Mass energy based economic models. Hierarchical systems. Simulation exercises of agricultural energy and other socio-economic systems. Case studies.

**EE-604 Optimization of Engineering Systems** **3+0** **Sem. II**

**Unit I** Mathematical preliminaries. Performance index approach to dynamic systems. Notion of optimum parameters. Control strategies.

**Unit II** Parameter optimization by steepest descent, conjugate gradient, Davidsons' and Newton's search methods. Optimum controls and strategies. Newton-Kantorovich method for minimization of non-linear functions.

**Unit III** Gradient and conjugate direction methods in function spaces. Optimization of trajectories.

**EE-691 Seminar I** **1+0**

**EE-692 Seminar II** **1+0**

**EE-699 Ph.D Research** **0+75**

# COMPUTER SCIENCE AND ENGINEERING

## PROGRAMMES

**M. Tech.**

## COURSE REQUIREMENTS

**M. Tech.**

| | |
|---|---|
| Field of Specialization | Computer Science and Engineering |
| Required Courses | CSE-502, CSE-505, CSE-506 |
| Supporting Courses | Stat.-502, or courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem can be taken as per recommendation of student's advisory committee. |
| Minor Field | Courses from the discipline of Information Technology/ Electrical Engineering/ Math & Stat or any other course(s) from any other department can be taken as per recommendation of the student's advisory committee. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**CSE 101 Information and Communication Technology in Agriculture 1+2 Sem. I,II**

**(All degree programmes except B.Tech-Agril. Engg.)**

IT and its importance. IT tools, IT-enabled services and their impact on society; Introduction to Computers, hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; Operating Systems, definition and types, Applications of Word Processing /Spreadsheet /Presentation /Databases for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database concepts and types, uses of DBMS in Agriculture; Introduction to Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTML and IP and Video conferencing, Introduction to e- Agriculture, concepts and applications, Use of ICT in Agriculture.

**Practical:** Practice with latest operating system for Creating, Files Folders, File Management. Use of Word Processing / Spreadsheet / Presentation / Databases with latest software packages; Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. Creating Database, preparing queries and reports, Creation and operation of Email account; demonstration of Agri-information system using Mobile Apps. Internet applications: Web Browsing, Creation and operation of Email account; handling of audio visual equipments. Planning, preparation, presentation of posters, charts. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

**CSE 102 Basics of Computer Science and Bio-informatics in Agriculture 1+2 Sem. I**

Information Technology (IT) and its importance. IT Tools. IT-enabled services and their impact on society: Introduction to computers, hardware and software, input and output devices, word and character representation: features of machine language, assembly language, high-level language and their advantages and disadvantages: Operating System, definitions and types. Applications of word processing/Spreadsheet/Presentation: document creation and editing, data presentation, interpretation and graph creation, statistical analysis, mathematical expressions. Introduction to Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTL and IP and Video Conferencing, Introduction to e-Agriculture concepts and applications, Use of ICT in Agriculture.

**Bio-Informatics:**

Introduction to Bioinformatics and its application in Agriculture, Database concepts and types, uses of DBMA in Agriculture: Biological databases: NCBI searching.

**Practical:** Practice with latest operating system for creating Files and Folders, File Management, Use of Word Processing/Spreadsheet/Presentation with latest software packages: Creating spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. Creation and operation of Email account: demonstration of Agri-information system using Mobile Apps, Internet Applications: Web Browsing, Creation and operation of Email account: handling of audio-visual equipment's. Planning preparation, presentation of Posters, charts, Searching and retrieval of information from biological databases, Sequence alignment using BLAST.

**CSE 204 Computer Programming & Data Structures 1+2 Sem. I,II**

Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

**Practical:** Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making

statements such as if, go to & switch; Developing program using loop statements while, do & for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers; Implementing Stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/Deletion in data structures.

**CSE 205 Web Designing and Internet Applications** **1+1** **Sem. II**

Basic principles in web designing, planning process, rules of web designing, designing navigation bar, page design, homepage layout, design concept. Basics in Web Design: basic HTML tags, attributes and elements, adding images, creating tables, developing web pages, changing layout using cascading style sheets. Brief history of Internet, World Wide Web, creation of a web site, Web standards. Introduction to JavaScript, variables and functions, working with alert, confirm and prompt. Basic concepts of database.

**Practical:** Use of available software for: Animation concept, understanding animation for web, animation interface, working with animation tools. Exploring web development software interface, planning & setting website structure, working with panels, understanding and switching views, using property inspector, formatting text. Java Script: working with alert, confirm and prompt, understanding loop, arrays, creating rollover image, working with operators. File Transfer Protocol: learning to use FTP, setting up FTP server, uploading of site, using control panel. Understanding GIF animation interface, knowing GIF file format, creating basic web banners, creating web banners with effects, creating animated web buttons. Project.

## Postgraduate Courses

**CSE-501 Big Data Analytics** **2+1** **Sem. I**

**Unit-I** Data analysis, data matrix attributes. Data: Algebraic and geometric view, probabilistic view.

**Unit-II** Basics of data mining and CRISP-DM, organizational and data understanding, purposes, Intents and limitations of data mining, database, data warehouse, data mart and data set, types of data, privacy and security, data preparation, collation and data scrubbing.

**Unit-III** Data mining models and methods, correlation, association rules, k-means, clustering understanding of concept, preparation and modeling.

**Unit-IV** Discriminant analysis, linear regression, logistic regression, understanding, preparation and modeling.

**Unit-V** Decision trees, neural networks, understanding, preparation and modeling.

**Practical :** Introduction to OpenOffice and RapidMiner in data analytics and mining. Preparing RapidMiner, importing data, handling missing data, data reduction, handling Inconsistent data, attribute reduction. Performing different analysis using RapidMiner or suitable software.

**CSE-502 Artificial Intelligence** **2+1** **Sem. I,II**

**Unit-I** Definitions of intelligence and artificial intelligence. What is involved in intelligence? Disciplines important to AI. History of development of AI. Different types of AI. Acting humanly, Turing test. AI systems in everyday life. Applications of AI.

**Unit-II** Classical AI, concept of expert system, conflict resolution, multiple rules, forward chaining, backward chaining. Advantages and disadvantages of expert system. Fuzzy logic and fuzzy rules. Fuzzy expert systems.

**Unit-III** Problem solving using AI, search techniques, breadth first search, depth first search, depth limited search, bidirectional search, heuristic search, problems and examples. Knowledge representation, frames, methods and demons, correlations, decision trees, fuzzy trees.

**Unit-IV** Philosophy of AI, Penrose's pitfall, weak AI, strong AI, rational AI, brain prosthesis experiment, the Chinese room problem, emergence of consciousness, technological singularity, Turing test.

**Unit-V** Modern AI, biological brain, basic neuron model, perceptrons and learning, self-organizing neural network, N-tuple network, evolutionary computing, genetic algorithms, agent methods, agents for problem solving, software agents, multi agents, hardware agents.

**Practical :** Prolog language, syntax and meaning of Prolog programs, Lists, operators, arithmetic. Using structures: Example programs, controlling backtracking, input and output. more built-in procedures, programming, style and technique, operations on data structures. Advanced tree representations, basic problem-solving strategies, depth-first search strategy, breadth-first search strategy.

**CSE-503 Neuro-Fuzzy Applications in Engineering 2+1 Sem. I**

**Unit-I** Basic concepts of neural networks and fuzzy logic, differences between conventional computing and neuro-fuzzy computing, characteristics of neuro-fuzzy computing.

**Unit-II** Fuzzy set theory: Basic definitions, terminology, formulation and parameters of membership functions. Basic operations of fuzzy sets: Complement, intersection, vision, T-norm and Tconorm. Fuzzy reasoning and fuzzy Inference: Relations, rules, reasoning, Inference systems,and modeling. Applications of fuzzy reasoning and modeling in engineering problems.

**Unit-III** Fundamental concepts of artificial neural networks: Model of a neuron, activation functions, neural processing. Network architectures, learning methods. Neural network models: Feed forward neural networks, back propagation algorithm, applications of feed forward networks, recurrent networks, hopfield networks, hebbian learning, self organizing networks, unsupervised learning, competitive learning.

**Unit-IV** Neuro–fuzzy modeling: Neuro-fuzzy inference systems, neuro-fuzzy control.

**Unit-V** Applications of neuro-fuzzy computing: Time series analysis and modeling, remote sensing, environmental modeling.

**Practical :** Training algorithms of artificial neural networks: Basic models, learning rules, single layer and multi-layer feed-forward and feedback networks, supervised and unsupervised methods of training, recurrent networks, modular networks. Fuzzy systems: Fuzzy sets, operations on fuzzy sets, fuzzy relations, measures, fuzzy logic, fuzzy logic controller, integrated hybrid systems. Adaptive neuro-fuzzy inference systems, coactive neuro-fuzzy modeling, classification and regression trees, data clustering algorithms like k-means, fuzzy c-means, mountain and subtractive clustering, rule-based structure identification, neuro-fuzzy control, case studies. Use of available software for fuzzy logic and neural networks.

**CSE-504/ MCA-516 Soft computing Techniques in Engineering 2+1 Sem. I**

**Unit-I** Introduction to control techniques, need of intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule based systems, the artificial intelligence approach. Knowledge representation and expert systems. Data pre-processing: Scaling, Fourier transformation, principle component analysis and wavelet transformations.

**Unit-II** Concept of artificial neural networks (ANN) and basic mathematical model, network structures, activation function, back propagation, network size and pruning McCulloch-Pitts neuron model, simple perceptron, daline and madaline neural networks, feed-forward multilayer perceptron. Learning and training the neural network. Networks: Hopfield network, self-organizing network and recurrent network. Neural network based controller. Case studies: Identification and control of linear and nonlinear dynamic systems.

**Unit-III** Genetic algorithm (GA): Basic concept and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using GA. Concept of other search techniques like tabu search and ant-colony search for solving optimization problems.

**Unit-IV** Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to Fuzzy logic modeling and control of a system. Fuzzification, inference and defuzzification. Fuzzy knowledge and rule bases.

**Unit-V** Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Implementation of fuzzy logic controller. Stability analysis of fuzzy control systems. Intelligent control for SISO/MIMO nonlinear systems. Model based multivariable fuzzy controller.

**Practical :** To work on data transformations, brief review on statistical criteria for termination of epochs, deciding the input output and hidden layers and neutrons for ANN problems, working on different

algorithms of ANN to different problems in agricultural engineering, working with different fuzzy relations, propositions, implications and inferences, working with defuzzification techniques and fuzzy logic controllers, concept of coding, selection, crossover, mutation and application of genetic programming for global optimization, use of available software for application of soft computing techniques.

**CSE-505/ MCA-506 Database Management Systems** **2+1** **Sem. I,II**

**Unit I** Overview of DBMS, basic DBMS terminology, advantages and disadvantages of DBMS, file approach and its limitations, DBMS approach, advantages of DBMS, DBMS components.

**Unit II** Design, logical and physical data independence, three level architecture of DBMS, entities and types of entities, relationships, entity relationship model.

**Unit III** Data models, relational model, network model, hierarchical model, comparison of data models. Relational model, storage organizations for relations, primary, secondary, candidate, alternate keys, relational algebra & relational calculus, functional dependencies and normalization.

**Unit IV** Functional relational query language, SQL commands, DCL, DDL, DML and TCL. PL/SQL, variables, control structures, decisions and loops, functions and procedures, cursors and triggers.

**Practical :** E-R diagram construction, SQL, version of SQL, commands syntax, data types, DDL statements, DML statements, DCL statements, TCL statements, having clauses, order by and where clause, wild cards, operators, integrity constraints, primary key, reference key, check, unique, not null, index and views, sequences, functions, aggregate functions, numerical, string, date and time, sub queries, nesting of queries, normalization of database and case study on a database design and implementation. PL/SQL, variables, control structures, decisions and loops, exception handling, creating functions and procedures, cursors, implicit and explicit cursors, triggers.

**CSE-506 Digital Image Processing** **2+1** **Sem. I,II**

**Unit-I** Digital image fundamentals, elements of visual perception, light and the electromagnetic spectrum, image sensing and acquisition, image sampling and quantization, basic relationships between pixels, linear and nonlinear operations.

**Unit-II** Image enhancement in the spatial domain, basic gray level transformations, histogram processing, basics of spatial filtering, smoothing spatial filters, sharpening spatial filters.

**Unit-III** Color image processing, color fundamentals, color models, pseudo color image processing, basics of full-color image processing, color transformations, smoothing and sharpening, color segmentation.

**Unit-IV** Image segmentation, detection of discontinuities, edge linking and boundary detection, thresholding, region-based segmentation, segmentation by morphological watersheds.

**Unit-V** Morphological image processing, dilation and erosion, opening and closing, extensions to gray-scale images.

**Practical :** To write program to read and display digital image, image processing program using point processing method, program for image arithmetic operations, program for image logical operations, program for histogram calculation and equalization, program for geometric transformation of image, understand various image noise models and to write programs for image restoration and to remove noise using spatial filters. Brief outline of image processing tools.

**CSE-507/ EE-504 Process Control System** **2+1** **Sem. I**

**Unit I** Introduction to Process Control - Control strategy, single variable and multi variable control systems, Process Control loop, Open loop and closed loop control system, Linear and non-linear control system.

**Unit II** Determining the Transfer function of Complex Control System, Representation of a Control System by block diagram and its Reduction Characteristics. Process Equation. Controlling and Controlled Variable. Transient & steady state response, Self-Regulation Property.

**Unit III** Control System Parameters, Evaluation of control System. Controller Modes or actions - ON/ OFF Mode, Proportional Mode, Integral Mode, Derivative Mode, Composite control Modes. Pressure regulation, Liquid level and Temperature control Systems. Signal Conditioning,

**Unit IV** Design of OP AMPS circuits used to implement Proportional, Integral, Derivative and Composite Modes. Introduction to computer control of process. Applications and design.

**Practical :** Study of performance of thermister, LVDT, thermocouple, strain gauge; open loop control systems, feedback control system; PI, PD, PID Controller; Simulation of typical control systems; use of microprocessors in process control.

**CSE-508 Computer Engineering** **2+1** **Sem. I**

**Unit I** Review of basic digital circuits and codes. Digital computer components. Memories.

**Unit II** Instructions and digital computer operations. Arithmetic and control sections. Input-output equipment.

**Unit III** Design of a selected system.

**Practical :** Application of logic gates in half and full - adders. Code converters and display devices. Study of computer systems with logic analyzer.

**CSE-509 Parallel Programming** **1+2** **Sem. I**

**Unit I** Single/Multi core Processor Architecture, Basic parallel computing,

**Unit II** Construct and Functions, OpenMP/MPI, Point to point communications, Collective communications

**Unit III** Advanced MPI1 concepts, MPI2 introduction Hybrid (OpenMP + MPI) programming. Practical: Parallel Program based on OpenMP/MPI,

**Unit IV** Scheduling of High Performance cluster algorithm; Programs on Data types, Blocking Send and Receive.

**Practical :** Parallel Program using Open MP/MPI, Programs on Performing Parallel Rank with MPI, MPI Broadcast and Collective Communication, Point-to-Point Communication Application, Array Decomposition, Matrix Multiply, Blocking send-receive, Non-blocking send-receive, Collective communications, Contiguous derived data type.

**CSE-510 Software Engineering** **2+1** **Sem. II**

**Unit I** Software development cycle. Analyzing a software problem, designing and programming solution, testing results, making changes. Project planning.

**Unit II** Requirement analysis: fundamentals and methods. Software design fundamentals. Software quality assurance. Software testing techniques. Software testing strategies.

**Unit III** Software maintenance and configuration management. Introduction to software reliability and selected models.

**Practical :** Open source software based case studies, C++ programs for Software testing, Line Count Programs for Software analysis.

**CSE-511 Computer Networks** **2+1** **Sem. I**

**Unit I** Introduction, history and development of computer networks, networks topologies.

**Unit II** Message and packet switching, data communication nodes and message handling, flow control. Protocols, interprocessor communication, terminal handling, Routing algorithms.

**Unit III** Analysis, performance, optimization and design of networks. Random access channels; packet broad- casting; satellite communication. Study of networks: ETHERNET, ARCNET etc.

**Practical :** LAN IP configuration, Projects, Programs for Client server Communication, Programs using TCP and UDP Sockets.

**CSE-512 System Programming** **3+0 Sem. II**

**Unit I** Machine structure; Machine language; Assembly languages; Design of assemblers, Symbol table organization, pacing and segmentation

**Unit II** Stock and multiple register; machine code and storage optimization; Input and output control systems and debugging tools.

**Unit III** Design of macro assemblers. Micro assembly systems, Macro as generalized string processor; Algebraic expression-translation and interpretation. Design of loaders and linkage editors

**Unit IV** Design and direct linking and relocatable loaders; core image builder, overlay structure and dynamic loading, Interpreters, compilers and supervisors.

**CSE-513/ EE-512 Internet of Things** **2+1 Sem. I,II**

**Unit I** Introduction to IoT and its working, Difference between Embedded device and IoT device; Properties of IoT device; IoT Decision Framework; IoT Solution Architecture Models; Understand Sensing actions; Understand Actuators and Micro electro mechanical Systems.

**Unit II** Communication Protocols used in IoT: Types of wireless communication; Major wireless Short-range communication devices; properties; comparison of these devices (Bluetooth, Wireless Fidelity (WiFi), Major wireless Long-range communication devices; properties

**Unit III** IoT Applications: Industrial Internet; Applications such as: Smart Homes; Wearables; Smart City; Smart Grids; Connected Car; Connected digital health; telehealth; telemedicine; smart retail.

**Unit IV** Sensors: Applications of various sensors: Google Maps; Global positioning sensors: Global Positioning System; Global Navigation Satellite System; Indian Regional Navigation Satellite System; Galileo and indoor localization systems; Motion & Orientation Sensors: Accelerometer; Magnetometer; Proximity Sensor; Gyroscope.

**Practical :** Use of Open source to develop IOT devices. Design and build systems that will use sensors; communication protocols and actuators.

**CSE-514/ MCA-515 Cryptography and Computer Security** **2+1 Sem. I**

**Unit I** History of cryptography, Computer Security Concepts; Threats, Attacks and Assets. Cryptographic Protocols: Introduction to Protocols; Communications using Symmetric Cryptography; Substitution Ciphers and Transposition Cipher; Block Cipher; Steam Cipher

**Unit II** Modes of Operation; Symmetric and Asymmetric cryptography. Cryptographic Techniques: Key Length & Management: Symmetric Key Length; Public-Key Key Length; Generating Keys.

**Unit III** Algorithms: DIFFIE-HELLMAN; RSA; DES. Practical Cryptography: Encryption; authentication; hashing; Network Security and Protocol Standards: Network security issues; sniffing; IP Spoofing; Common threats; E-mail security;

**Unit IV** Secure Socket Layer (SSL); Transport Layer Security (TLS); SSH; Intruders; Virus; Worms; Firewalls-need and features of firewall: Types of firewall; Intruder Detection Systems.

**Practical :** Use of Network Security Tools; Email Header Analysis; Packet sniffing; configuration of network security equipment such as firewall; routers; IDS; Wireless Access Points.

**CSE-515 Computer Methods in Engineering** **0+3 Sem. II**

**Unit I** Introduction to computer hardware and operations, operating system, introduction to programming and numerical techniques

**Unit II** Spreadsheet-based application, simulation, modeling and optimization, data base management, graphics application, computer-based instrumentation for data acquisition and control.

**CSE-516 Machine Learning in Agriculture** **2+1 Sem. I**

**Unit I** Basics of Machine Learning: Processes involved in Machine Learning; Applications of Machine Learning. Machine Learning Techniques: Supervised Learning; Unsupervised Learning; Real life examples of Machine Learning.

**Unit II** Supervised Learning: Classification and Regression: K-Nearest Neighbor; Linear Regression; Logistic Regression; Support Vector Machine (SVM)

**Unit III** Evaluation Measures: Sum of squares error; R square; confusion matrix; precision; recall; F-Score; ROC-Curve.

**Unit IV** Unsupervised Learning: Introduction to clustering; Types of Clustering: Hierarchical-Agglomerative Clustering and Divisive clustering

**Unit V** Partitioned Clustering; K-means clustering; Principal Component Analysis. Applications of Machine Learning in Agriculture

**Practical :** Python Introduction: Loops and Conditions and other preliminary stuff; Functions; Classes and Modules; Exceptions; Database access; Mathematical computing with Python packages, Application Oriented Project Work.

**CSE-517 Cloud and Mobile Computing** **2+1** **Sem. II**

**Unit I** Introduction to Cloud Computing, Cloud Computing Architecture, Service Management in Cloud Computing, Data Management in Cloud Computing

**Unit II** Resource Management in Cloud, Cloud Security, Open Source and Commercial Clouds, Cloud Simulator.

**Unit III** Mobile Applications: Responsive Web Design vs. Mobile Apps; RESTful and Non-RESTful apps; Native Vs Hybrid

**Unit IV** Security and Trust Management, Privacy and Ethics, Usability and Accessibility

**Practical :** Installation of Private Clouds using open source softwares. Cross platform applications based on HTML/CSS/JS Framework, Creating and Incorporating Web/Cloud Services for mobile applications; Publishing the apps to various App stores.

**CSE-518/ EE-507 Microprocessor and Embedded Systems** **2+1** **Sem. II**

**Unit I** Microprocessor: Architecture, Register Organization, Programming Model, Memory Segmentation, Addressing Modes

**Unit II** Instruction set. Microcontroller: Architecture, I/O Ports, Memory Organization, Instruction set, Brief overview of real time systems and embedded systems

**Unit III** Classification of embedded systems – Embedded system definitions – Functional and non-functional requirements – architectures and standards – Core of embedded system, sensors and actuators.

**Practical :** Hands-on experience in the use of microcontroller system and design of peripheral controllers and interfaces along with construction and debugging of IC circuits.

**CSE-519/ EE-513 Wireless Sensor Networks** **1+1** **Sem. I**

**Unit I** INTRODUCTION: Motivation for a Network of Wireless Sensor Nodes – Definitions and Background, Challenges and constraints; Applications of wireless sensor networks.

**Unit II** PHYSICAL LAYER: Basic Components, Source Encoding, Channel Encoding, Modulation, Signal Propagation, MEDIUM ACCESS CONTROL: Overview, Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks

**Unit III** Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols, POWER MANAGEMENT: Local Power Management Aspects, Dynamic Power Management, Conceptual Architecture, TIME

**Unit IV** SYNCHRONIZATION: Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols

**Unit V** LOCALIZATION: Overview, Ranging Techniques, Range-Based Localization, Range-Free Localization.

**Practical :** Implement simulation experiments and projects based on Physical layer, network layer, transport layer, application layer and MAC layer of wireless sensor network.

**CSE-591 Seminar** **1+0**

**CSE-599 Master's Research** **0+30**

# INFORMATION TECHNOLOGY (MCA)

## PROGRAMMES

### Master of Computer Applications (MCA)

## COURSE REQUIREMENTS

### Master of Computer Applications (MCA)

| | |
|---|---|
| Field of Specialization | Information Technology (MCA) |
| Required Courses | MCA-503, MCA-506, MCA-508 |
| Supporting Courses | Stat.-502 or courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problem can be taken as per recommendation of student's advisory committee. |
| Minor Field | Courses from the discipline of Computer Science and Engineering / Electrical Engineering / Math & Stat or any other course(s) from any other department can be taken as per recommendation of the student's advisory committee. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Postgraduate courses

**MCA-501 Computer Fundamentals and Programming** **2+1 Sem. I**

**Unit I** Computer fundamentals, number systems, decimal, octal, binary and hexadecimal, representation of integers, fixed and floating-point numbers, character representation, American Standard Code for Information Interchange (ASCII), Extended Binary Coded Decimal Interchange Code (EBCDIC)

**Unit II** Functional units of computer, I/O devices, primary and secondary memories. Programming fundamentals with C, techniques of problem, solving, flowcharting, stepwise refinement

**Unit III** Representation of integer, character, real numbers, data types in C, constants and variables, arithmetic expressions, assignment statement, logical expression. Sequencing, alteration and iteration, arrays, string processing

**Unit IV** Sub-programs, recursion, pointers and files. Program correctness, debugging and testing of programs.

**Practical :** Conversion of different number types, creation of flow chart, conversion of algorithm/flowchart to program, mathematical operators, operator precedence, sequence, Implementing subprograms and recursion. Debugging and testing, Control statements, looping and decision-making statements, arrays and string processing, pointers and file processing.

**MCA-502 Computer Organization and Architecture** **2+0 Sem. I,II**

**Unit I** Number systems, Karnaugh algebra, minimization of Karnaugh function using Karnaugh map, logic gates, combinations circuits, MUX, DEMUX, encoder, decoder, sequential circuits, flip-flops, half and full adder, shift register, counters.

**Unit II** Organization of CPU, control unit, instruction and execution cycle in CPU, register organization, the instruction cycle, instruction pipelining. Memory organization, internal memory, semiconductor main memory (RAM, ROM, EPROM), cache memory, advanced DRAM organization, external memory

**Unit III** Magnetic disks, RAID, optical memory, magnetic tape. Basic structure of computer hardware and system software, addressing methods and machine program sequencing, input-output organizations, accessing I/O devices, Direct Memory Access (DMA), interrupts. CISC and RISC architecture, study of functional units of microprocessors.

**MCA-503 Internet and Web Technologies** **3+1 Sem. I,II**

**Unit I** Fundamentals of networking, overview of network topologies, classifications of networks. Introduction to the internet, advantages and disadvantages of internet, electronic mail, gopher, world wide web, Usenet, telecommunication networks, bulletin board service, wide area information service

**Unit II** Introduction to HTML, comparing static and dynamic web designing, elements, versions, designing a web page, text formatting & alignment, font control, arranging text and lists, background image & colors, images in web pages, method of linking, frames, user input using forms, event handling,

**Unit III** Applying style formats using Style sheets, types of SS, external and inline and embedded style sheets. Java script introduction, variables, control statements, JavaScript arrays, methods, client side validations, embedding JavaScript, future of JavaScript.

**Unit IV** Server side scripting, installing and configuring web server, creating DSN, database interaction using server side scripts, database connectivity using DSN and DSN less, retrieving and searching data, adding and modifying contents of database.

**Practical :** Designing static website with features like tables, hyperlink among pages, pictures, frames, client side scripts for user interface validation, arrays, methods, branching and iterations, server side scripting for database interaction, database creation, retrieving and accessing databases, filters, and designing of an information system.

**MCA-504 Dynamic Web Development** **3+1 Sem. II**

**Unit I** Dynamic Hyper Text Markup Language, using text formatting tags, tables, lists, images and image map, frames and frameset and forms for user input. Form elements, textbox, checkbox, radio buttons, selection lists, dropdown list, multiple selection, text area, field set, legend, hidden fields, uploading files, mailto information, get and post method

**Unit II** Types of dynamic scripting languages, overview of dynamic scripting languages, features of dynamic scripting languages. Client side and server side scripting, dynamic scripting language constructs, variables, loops and decisions, functions and procedures. Dynamic language features, introspection, mobility, instrumentation, garbage collection, importance and need, factors affecting garbage collection algorithms, mark and sweep garbage collection algorithm

**Unit III** Typing, static versus dynamic typing, manifest versus inferential typing. Implementing client side validations and database interaction using server side scripts. Latest trends in programming on the emerging technologies relating to web based software development.

**Practical :** Developing tables, frames, DHTML tags in dynamic WebPages in JavaScripts/VB scripts. Creating dynamic WebPages using different form elements, textbox, checkbox, radio buttons, selection lists, dropdown list, multiple selection, text area, field set, legend, hidden fields, uploading files, mailto information, get and post method.

**MCA-505 Multimedia and Applications** **2+1 Sem. II**

**Unit I** Introduction to multimedia technology, use of computers in communications and entertainment. Framework for multimedia systems. Multimedia devices, presentation devices and the user interface.

**Unit II** Digital representation of sound and transmission, speech recognition and generation, digital video and image compression, JPEG image compression standard, MPEG motion video compression. Presentation and multimedia authoring, implementing layouts, designing of visuals

**Unit III** Applying animations and transitions, creating hyperlinks and actions, templates, wizards and views, inserting pictures, charts, tables, objects, movies and sounds, customizing a show, using a standard presentation software.

**Unit IV** Introduction to Adobe Photoshop, basic color models, CMYK, RGB, bitmap graphics, vector graphics, images and image editing. Filters and layers.

**Practical :** Layouts and designing of visuals, basics of colors, working with text, presentations, charts and putting animations, views, graphics, adding audio and videos, creating interactive presentations. Adobe Photoshop, introduction, working with images, image editing and cleaning. Panning and zooming, cropping images, morphing, building layers and adding filters, effects.

**MCA-506/ CSE-505 Data Base Management System** **2+1 Sem. I,II**

**Unit I** Overview of DBMS, basic DBMS terminology, advantages and disadvantages of DBMS, file approach and its limitations, DBMS approach, advantages of DBMS, DBMS components.

**Unit II** Design, logical and physical data independence, three level architecture of DBMS, entities and types of entities, relationships, entity relationship model.

**Unit III** Data models, relational model, network model, hierarchical model, comparison of data models. Relational model, storage organizations for relations, primary, secondary, candidate, alternate keys, relational algebra & relational calculus, functional dependencies and normalization.

**Unit IV** Functional relational query language, SQL commands, DCL, DDL, DML and TCL. PL/SQL, variables, control structures, decisions and loops, functions and procedures, cursors and triggers.

**Practical :** E-R diagram construction, SQL, version of SQL, commands syntax, data types, DDL statements, DML statements, DCL statements, TCL statements, having clauses, order by and where clause, wild cards, operators, integrity constraints, primary key, reference key, check, unique, not null, index and views, sequences, functions, aggregate functions, numerical, string, date and time, sub queries, nesting of queries, normalization of database and case study on a database design and implementation.

PL/SQL, variables, control structures, decisions and loops, exception handling, creating functions and procedures, cursors, implicit and explicit cursors, triggers.

**MCA-507 Visual Programming** **1+2** **Sem. II**

**Unit I** Visual fundamentals, building your first application, developing applications in visual programming, working in the visual programming environment

**Unit II** Using the intrinsic controls, working with projects, working with properties, deploying visual applications, advanced programming, debugging, creating controls

**Unit III** Using active X controls, your applications, database programming, database basics and the data control. Making reports, enhancing the programming using the advanced data controls.

**Practical**: Programs for loops, typecasting. Developing user friendly programs in visual environment / platform on Linux/windows, methods and events, programming using data types, constants and variables, making statements in a program, working with conditional statements, working with loops, working with arrays, working with strings and typecasting, the elements of visual environment, creating menus, forms and dialog boxes, handling keyboard and mouse input, working with time and timers, adding graphics, writing reusable code with subs and functions, saving and retrieving data. Accessing Databases using advance Data control.

**MCA-508 Programming in C++** **2+2** **Sem. I**

**Unit I** Introduction to C++, character set, constants, variables and keywords and their types. Operators, type conversion. Control statements, conditional expression. Declaration of variables, statements, simple C++ program, manipulator functions, I/O stream flags.

**Unit II** Functions, types of functions, local and global variables, default arguments, multifunction program. Storage class specifiers, pre-processor, header files and standard functions.

**Unit III** Arrays, declaration, initialization, processing with array, array with functions, strings and their functions.

**Unit IV** Overview of classes and objects, definition, structures and classes, member functions, defining object, accessing a member, array of class objects, classes within classes. The I/O library and file handling, operations on files.

**Practical :** Programs on use of decision making statements in C++,using iterations and arrays, multidimensional array, input output manipulators, predefined manipulators and user defined manipulators, formatted and unformatted input output functions, set precision, user defined objects, defining function, return statement, Classes and Objects, using constructors and destructors in classes, object as a member, Member Functions, call and return values, passing parameters, actual and formal arguments, recursion, I/O library files, macros, stream buffers, istream, ostream and fstream, file handling, saving files on disk, reading contents from files, editing files, apply file modes, type of files.

**MCA-509 Data Structures and Algorithms** **2+2** **Sem. II**

**Unit I** Overview of data structures, basic concepts, data organization, description of various data structures. Programming design and development. Algorithms, programming constructs algorithm complexity,

**Unit II** Big O notation, and concept of recursion. Arrays and matrices, stack, stack insertion and deletion, queue, circular queues, priority queues, link list, Representation and processing of linear linked lists, multiple linked structures, creating link list, inserting and deleting link nodes from a list, circular link list, doubly link list,

**Unit III** Trees, traversing a tree, traversal methods, depth, level and height of a tree, binary tree, BST, AVL tree, threaded binary trees, M-Way search trees, B-Tree, heaps, multi way trees. Graphs, demonstrating graphs in memory, operations on graphs, applications of graphs.

**Unit IV** Searching and sorting, searching, linear search and binary search algorithm, hash list searches, collision resolution. Bubble sort, selection sort, insertion sort, radix sort, merge sort algorithm, quick sort, heap sort, shell sort.

**Practical :** Implementation of various types of structures, programs for array and multidimensional arrays, linked lists, doubly linked lists, circular linked lists, queue, de- queue, stack and tree, in-order, preorder and post-order tree traversals, string processing, searching and sorting techniques, graph and geometric algorithms and case studies.

**MCA-510 Core Java** **2+** **Sem. I**

**Unit I** Features of java, java and internet, java and www, hardware and software requirements, java support systems,

**Unit II** Java environment, java classes, access modifiers, managing classes and calling methods, inheritance, overloading,

**Unit III** Packages & interfaces, exception handling, multiple catch statements, finally statement, creating user defined exceptions, multi threading, thread control methods, thread life cycle, applets and webpages.

**Practical :** Programs on java classes, methods, string class, decision making control statements, looping control statements, jumping statements, vectors, operators, arrays, multidimensional arrays, passing arrays to functions, array of objects, string handling in java, string functions, inheritance, types of inheritance, inheritance accessing modes, runtime and compile time binding, packages, importing classes and packages, interfaces, runnable interfaces, exception handling, types of exceptions, throwing exceptions, catch and try block, multiple catch blocks, finally keyword, multi threading, prioritizing the threads, Designing applets in WebPages, Extending applet class, I/O applets, importing classes and packages, extending applet class.

**MCA-511 Data Communication and Networks** **2+0** **Sem. II**

**Unit I** Definition of a communication network, simplex, duplex and half duplex systems, concept of node nodes connected by links to create networks, names & addresses, the idea of “address resolution”.

**Unit II** Types of network, point-to-point connections, circuit-switched networks, message-switched networks, packet switched networks, datagram networks. Types of equipment, packet-switched network, types of communication-broadcast, unicast and multicast modes.

**Unit III** Open system interconnection, layers, responsibilities of each layer, TCP/IP model, transmission media, magnetic, twisted, coaxial cables and optical fiber, multiplexing, switching, terminal handling, telephone system, modems, connections, transmission media.

**MCA-512 Linux System Administration** **1+2** **Sem. II**

**Unit I** Linux basics, script command and utilities, booting process, HTTPD, CDI and PERL. Linux protocols, configuring TCP/IP, DNS, NFS and NIS, mailing, security, proxy server

**Unit II** Network management in Linux, shell programming. X-windows, principles, X programming model, calling motif functions, widget basics, text and list widgets etc., color basics.

**Practical :** Linux commands, Assign multiple IP’s, Assign second IP, Trace Route, Trace Path, Disable network card, Enable network card, View current routing table, Assign IP/Subnet, Display Current Configuration for all NIC’s, static IP address, Implementation of sever settings, administration commands, process related commands, network commands, IP Address Management, Installation of server using Network File System (NFS), mount system drives and fetching data using NFS, Managing network problems, script writing based on Linux using vi editors / emacs editors, constructs of shell programming.

**MCA-513 Concepts of Object Oriented Programming** **2+2** **Sem. I**

**Unit I** Introduction to object orientation, history and evolution of object oriented languages, Object Oriented Programming (OOP) languages (e.g. C++/Java etc.), abstract data types, classes, parameterized classes, objects, object/message paradigm

**Unit II** Data encapsulation, concepts of modules and interfaces, data abstraction and types, constructors and destructors, types of constructors, data hiding, overloading, operator overloading, binary and unary operator overloading, function overloading, constructor overloading, virtual class, pure virtual class, dynamic binding, polymorphism, virtual classes, inheritance

**Unit III** class hierarchies, relationships, inheritance and dynamic binding, single level inheritance, multiple inheritance, multilevel inheritance, hierarchical inheritance and hybrid inheritance, procedural abstraction, functional procedures,

**Unit IV** Object oriented software design, concept of modeling objects, object oriented analysis and design, importance, object oriented analysis landscape, object oriented design landscape, unified modeling language, structure diagrams, classes and states, object diagrams, class diagrams, interaction diagram, activity diagram, use case diagram, state machine diagrams, sequence diagram, behavior diagram, meta modeling.

**Practical :** Case studies using Object Oriented Analysis And Design (OOAD), creation of classes with features, overloading, programs using inheritance, multilevel and multiple inheritance, hybrid and hierarchical inheritance, data abstraction, polymorphism, programs for binary and unary operator overloading, function overloading, and implementation of a case study.

**MCA-514 Design and Analysis of Algorithms 3+0 Sem. I**

**Unit I** Elementary algorithmic, problem and instances, the efficiency of algorithms, average and worst case analyses, some examples, asymptotic notation, analysis of algorithms, greedy algorithms, general characteristics of greedy algorithms, Set and disjoint set union

**Unit II** Stassen's matrix multiplication graphs, minimum spanning trees, kruskal's algorithms, prim's algorithms, graphs, adjacency matrix, cost adjacency matrix, shortest paths, traversing graphs, the knapsack problem, scheduling, minimizing time in the system, scheduling with deadlines

**Unit III** divide and conquer, dynamic programming, exploring graphs, graphs and games, traversing trees, depth-first search, undirected graphs, articulation points, depth-first search, directed graphs, acyclic graphs, topological sorting, breadth-first search, backtracking, the knapsack problem,

**Unit IV** Computational complexity, information-theoretic argument, adversary argument, linear reductions, introduction to NP- completeness, Classes NP-Hard and NP-Hard Graph Problems (CNDP, DHC, TSP and AOG). Case Studies using divide and conquer searching and complexities. Algebraic General Method, Evaluation and Interpolation, Fast Fourier Transformation, Modular Arithmetic. Introduction to Absolute Approximation.

**MCA-515/ CSE-514 Cryptography and Computer Security 2+1 Sem. I**

**Unit I** History of cryptography, Computer Security Concepts; Threats, Attacks and Assets. Cryptographic Protocols: Introduction to Protocols; Communications using Symmetric Cryptography; Substitution Ciphers and Transposition Cipher; Block Cipher; Steam Cipher

**Unit II** Modes of Operation; Symmetric and Asymmetric cryptography. Cryptographic Techniques: Key Length & Management: Symmetric Key Length; Public-Key Key Length; Generating Keys.

**Unit III** Algorithms: DIFFIE-HELLMAN; RSA; DES. Practical Cryptography: Encryption; authentication; hashing; Network Security and Protocol Standards: Network security issues; sniffing; IP Spoofing; Common threats; E-mail security;

**Unit IV** Secure Socket Layer (SSL); Transport Layer Security (TLS); SSH; Intruders; Virus; Worms; Firewalls-need and features of firewall: Types of firewall; Intruder Detection Systems.

**Practical :** Use of Network Security Tools; Email Header Analysis; Packet sniffing; configuration of network security equipment such as firewall; routers; IDS; Wireless Access Points.

**MCA-516/ CSE-504 Soft Computing Techniques in Engineering 2+1 Sem. I**

**Unit-I** Introduction to control techniques, need of intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule based systems, the artificial intelligence approach. Knowledge representation and expert systems. Data pre-processing: Scaling, Fourier transformation, principle component analysis and wavelet transformations.

**Unit-II** Concept of artificial neural networks (ANN) and basic mathematical model, network structures, activation function, back propagation, network size and pruning McCulloch-Pitts neuron model, simple

perceptron, daline and madaline neural networks, feed-forward multilayer perceptron. Learning and training the neural network. Networks: Hopfield network, self-organizing network and recurrent network. Neural network based controller. Case studies: Identification and control of linear and nonlinear dynamic systems.

**Unit-III** Genetic algorithm (GA): Basic concept and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using GA. Concept of other search techniques like tabu search and ant-colony search for solving optimization problems.

**Unit-IV** Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to Fuzzy logic modeling and control of a system. Fuzzification, inference and defuzzification. Fuzzy knowledge and rule bases.

**Unit-V** Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Implementation of fuzzy logic controller. Stability analysis of fuzzy control systems. Intelligent control for SISO/MIMO nonlinear systems. Model based multivariable fuzzy controller.

**Practical :** To work on data transformations, brief review on statistical criteria for termination of epochs, deciding the input output and hidden layers and neutrons for ANN problems, working on different algorithms of ANN to different problems in agricultural engineering, working with different fuzzy relations, propositions, implications and inferences, working with defuzzification techniques and fuzzy logic controllers, concept of coding, selection, crossover, mutation and application of genetic programming for global optimization, use of available software for application of soft computing techniques.

**MCA-517 System Software** **3+0 Sem. I,II**

**Unit I** Introduction to software processors, elements of assembly language programming, assembly scheme, single pass and two pass assembler, general design procedure of a two pass assembler

**Unit II** macros and macro processor, macro definition, macro expansion, and features of macro facility, design of macro processor, overview of compilers, memory allocation, compilation of expressions, compilation of control structures

**Unit III** Use of interpreters, pure and impure interpreter, Compile and go loader, Absolute loader, Relocating loader, and direct linking loader. lexical analysis, syntax analysis, intermediate code generation and optimization, local and global optimization, assembly and output

**Unit IV** Loaders and linkage editors. Translated linked and load time addresses, relocation and linking concepts. Design of a linker, self relocating programs. Introduction to loading, linking and relocation, program linking, linkage editors, dynamic linking, bootstrap loader.

**Unit V** Other system software, database systems, functions and structure of text editor. Processor management, Scheduler, traffic controller, race condition, Information management.

**MCA-518 Operating System** **3+1 Sem. I**

**Unit I** Operating system overview, operating system as an extended machine and resource manager, operating system classifications, operating system modes and system calls. Operating system architecture.

**Unit II** Process, process model, process scheduling, operations on process, inter process communication. Process synchronization, critical section problem, producer consumer problem, bounded buffer problem, semaphores, monitors,

**Unit III** CPU scheduling, long term schedulers, middle term schedulers, short term schedulers, basic concepts, scheduling criteria, scheduling algorithms, First come first serve, shortest job first, priority scheduling, round robin, multilevel queue, multilevel feedback, deadlocks, system model, race condition, deadlock prevention, deadlock avoidance, deadlock detection.

**Unit IV**

Memory management, base register and limit register, contiguous memory allocation, swapping, paging, segmentation, virtual memory, fragmentation, demand paging, page replacement, first in first out, least recently used, optimal algorithm, thrashing, shared segment.

**Unit V**

Device management system, dedicated share and virtual devices, spooling channels, multiplexer and selector, control units, traffic controllers and device handlers.

**Practical**

Windows and Linux installation, managing files and folders in windows. Dos commands, user account settings, add and remove hardware and software's, group policies, user policies, administrator policies, services, disk formatting and partitioning, disk management and defragmentation, managing files and folders, synchronization, user profiles, windows components, event viewer, desktop settings, folder properties.

**MCA-519 Cyber Law in India** **1+0 Sem. I,II**

**Unit I** Overview of the IT legal system in India. Intellectual properties, copyrights, patents, privacy, computer forensics. Access Control : Operating system Access Controls, Group and Roles, Access Control lists, Operating System Security , Capabilities, Granularity, Sandboxing and Proof-carrying code, Hardware protection, Other technical Attacks.

**MCA-520 Network Programming** **2+1 Sem. I,II**

**Unit I** Introduction to networking and internet protocols via programming, TCP/IP, user datagram protocol, multicasting, standard internet services and protocol usage by common internet applications.

**Unit II** Sockets programming, client/server, peer-to-peer, internet addressing, TCP sockets, UDP sockets, raw sockets, multithreading and exception handling. Finger, Domain Name System, HTTP, and ping clients and servers.

**Unit III** Routers and architectures, routing protocols. Router and switch configurations, internet operating systems. Internetwork setup, wireless internetworking. Network protocol analyzers,

**Unit IV** Types of protocols, remote terminal access, types of servers, transaction based, inherent concurrency, strict turn-taking, stateless servers, traffic generation.

**Practical :** Handling TCP/IP protocol, programming TCP/IP parameters,. Implementation of remote terminal access, commands of HTTP, handling UDP, programming of UDP parameters. Network programming under Linux / windows, implementing socket programming, configuring peer to peer networks, routers and switch configuration in Linux and Windows.

**MCA-521 Design and Management of Web Portals** **2+1 Sem. I,II**

**Unit I** Web portals, definition, history, types of web portals, web portal services, search engine, indexing, FAQ, RSS feeds, E-mail alerts, live chat, blog, web portal design, management, security issues.

**Unit II** Introduction, features of XML, XML protocols, XML documents. Structure of XML, logical structure, physical structure. XML markup, element markup, attributes markup naming rules, elements, attributes, descriptors, comments entity.

**Unit III** Unrestricted elements, element content models, element sequences, element choices, combined sequences and choices. Viewing, xml in internet explorer, viewing xml using the xml data source object. XSL (Extensible Style Sheet Language) or CSS (Cascading Style Sheet).

**Practical :** Use of XML / PHP for designing web portals for agricultural informatics. Managing Session, using session variables and cookies, open source database connectivity (MySQL), CSS for designing web portals, managing users authentication, security issues on server side, managing user and passwords.

**MCA-522 Content Management** **1+2 Sem. I,II**

**Unit I** Strategy, scope, structure, skeleton, surface review. Compare and contrast OS-CMS options. Defining a successful online community, setting up a Joomla site, sections, categories, content, menu, wire framing, Joomla templates, evaluating Joomla extensions for community functionality and technical features, installing and configuring Joomla extensions, forming, storming, norming, and conforming.

**Practical :** Use of open source software tools for content management, create, update, and delete articles, display a list of articles, create a navigation menu and display articles in the front-end, auto-

archive articles older, Create a Website template, use of File System Object, use the VBScript function Replace() Create a Database for the Content developing e-learning modules. Templates, content languages, meta data, mail, stats, search engine friendly URL's, calendar, content items, native support for file types, multiple file transfer, file conversion tools, currency conversion, source editor, spell checker, XML editor, role management, media asset repository (Images, sound, flash, video etc).

**MCA-523 Data Warehousing & Data Mining** **2+1 Sem. I,II**

**Unit I** Concepts and principles of data warehousing, data warehousing architecture. System process and process architecture, data warehousing design, database schema. Partitioning strategy, aggregations, data marts, meta data management, and data warehouse process.

**Unit II** Query management, data warehouse security, backup, backup schedule, backup media, backup format, backup file format, restoring points, restoring backup files and recovery, recovery from deleted database, recover from damage disk, capacity planning, testing the warehouse. Introduction to data mining, neural networks, fuzzy logic. Visualization techniques, decision trees, association rules, statistical and clustering models.

**Practical :** Data warehouse design, selection of schema, normalization and renormalization, query plan strategy, performance tuning, backup, backup scheduling, restoring database and recovery of data warehouse, dynamic reporting and OLAP cubes, data mining techniques, neural networks, fuzzy logic, visualization techniques and decision trees.

**MCA-524 System Analysis And Design** **2+0 Sem. I**

**Unit I** System, concept, elements of a system and types of system, system development life cycle, role of system analyst, initial investigation, feasibility study, technical, economic and behavioral feasibility, cost and benefit analysis.

**Unit II** System analysis, problem definition, information requirements, information gathering tools, tools of structured analysis, data flow diagrams, data dictionary, decision tree, decision tables and structured English, system design, structured design, input design, and output design, form design, file organization, sequential, indexed sequential, chaining and inverted list organization, system testing, test plan and test data,

**Unit III** Types of system test, system implementation, implementation plan, activity network for conversion, combating resistance to change. Hardware/ software selection, procedure for selection, major phases in selection, make v/s buy decision, criteria for software selection.

**MCA-525 Object Oriented Software Engineering** **3+0 Sem. I,II**

**Unit I** Software engineering, software related problems, software engineering, concepts, and development activities. Modeling, modeling with UML. Project communications, project communication modes, mechanisms and activities. Requirements, requirements elicitation, concepts & managing requirements elicitation.

**Unit II** Analysis, analysis overview, activities and managing analysis. Design, design overview, fundamental concepts of system design, activities and managing system, design. Object design, object design overview, activities and managing object design.

**Unit III** Rationale management, rationale overview, concepts, activities and managing rationale. Software documentation procedures, Software reliability and quality assurance. Quality Metrics and software models. Testing, testing overview, testing fundamentals, activities and managing testing.

**Unit IV** Software configuration management, configuration management overview, concepts, activities and managing configuration management. Project management, project management overview, activities and managing project management models and activities. Software engineering tools and environment

**Unit V** International software engineering standards and their relevance Case studies in software engineering. Software Agents, Definition, Applications, Types and Classes, Multi- Agent systems, Characteristics & Properties Agents.

**MCA-526 Network Management** **1+2 Sem. I,II**

**Unit I** Network management architecture. Installing Windows Server, registry, control panel, Network applications, TELNET, FTP, Wired and wireless networking standards.

**Unit II** Microwaves, infrared, base band and broadband transmission. Network design and consideration, wired networks, wireless networks, network administration, system restoration. Simple network management protocol (SNMP), RMON 1, RMON 2. Management tools, systems and applications.

**Practical :** Basic Networking Concepts, Installing and configuring network server for window based and linux based systems, configuration protocols & bindings, network adapters, peripherals & devices, create users, managing users, managing group accounts, create policies, profiles ,system policies , user policies, Managing resources, disk resources, working with window resources, UNC, configure IP addresses in windows and linux , set up LAN network, managing network with respect to their topologies, ring topology set up wi-fi networks, managing E-mail, DHCP Practice of latest protocol/ network services on Linux / windows server.

**MCA-527 Parallel and Distributed Computing** **2+1 Sem. I**

**Unit I** Basic concepts of parallel computers and computation, parallelism and computing, von Neumann computer architecture, Flynn's classical taxonomy, general parallel technology, parallel computer memory architecture, Shared Memory, Distributed Memory, Hybrid Distributed-Shared Memory, Parallel Programming Models,

**Unit II** Shared Memory Model, Threads Model, Message Passing Model, Data Parallel Model, Other Models, Designing Parallel Programs, Automatic vs. Manual Parallelization, Understand the Problem and the Program, Synchronization, Data Dependencies, Load Balancing, Granularity, I/O, Limits and Costs of Parallel Programming,

**Unit III** Performance Analysis and Tuning, PI Calculation, Simple Heat Equation, 1-D Wave Equation, Distributed system models, cloud computing, Distributed System Challenges, connecting users and resources / concurrency, parallel machine model, parallel algorithm, designing parallel algorithms, methodical design, partitioning, communication, agglomeration, mapping, quantitative basis, performance evaluation, scalability analysis,

**Unit IV** Communication model, communication libraries, basics of PVM, MPI, BSP, clustering, grids types, computational grids, data grids. Grid computing, layered grid architecture, volunteer grid computing.

**Practical :** Parallel Program using Open MP/MPI, Programs on Performing Parallel Rank with MPI, MPI Broadcast and Collective Communication, Point-to-Point Communication Application, Array Decomposition, Matrix Multiply, Blocking send-receive, Non-blocking send-receive, Collective communications, Contiguous derived datatype.

**MCA-528 Server Programming with Java** **2+1 Sem. I,II**

**Unit I** Java AWT, Java AWT Package Container, Basic User Interface Components, Layouts. Java I/O Handling, I/O File Handling, File Input Stream, File Output Stream, File Class, Random Access File.

**Unit II** Socket Programming, Introduction, TCP/IP Protocol, UDP Protocol, Ports, Using TCP/IP Sockets, Using UDP Sockets. Database Connectivity using JDBC, JDBC/ODBC bridge, Driver Manager Class, Java SQL Package, SQL Exception class.

**Unit III** Remote Method Invocation, N-tier Architecture, Locating and loading Remote classes, Enabling remote method class, RMI Architecture, Naming, Remote Interface, Unicast Remote Object, Socket Vs RMI programming. Java Servlets, Introduction to Server Side Technologies, Servlet Life cycle, HttpServlets, GenericServlets, init(),service(), doGet(), doPost(), destroy(), Servlets and JDBC.

**Practical :** GUI problems using Java for Network, Java Connectivity with Web pages, Socket Programming, InetAddress Class, IP address resolver, Server socket, Datagram sockets, TCP sockets, stream sockets, Handling bytes, multicast sockets, JDBC connectivity, Loading database driver, oracle JDBC connection, Creating a JDBC Statement object, executing SQL statements.

**MCA-529 Next Generation Technologies** **2+1** **Sem. I**

**Unit I** Cloud Computing: Types of cloud, Applications of cloud, use of some common public cloud services, concept of Virtualization, Big Data

**Unit II** Analytics: Introduction to Big Data Platform, Traits of Big data, Challenges of Conventional Systems, sources, technologies, Applications, Cryptocurrency: Bit coins and cryptocurrency technology, use of block chain for cryptocurrency, success of cryptocurrency, cryptocurrency trading and wallets

**Unit III** Dark Web: Introduction to dark web, deep web, crawling the data from hidden web, data pre-processing and data analysis, tor network, case studies, Wireless technologies,

**Unit IV** Wearable Sensors: Implementation of wearable sensors, acquiring data from wearable sensors, applications: crowd sourced applications, Case Studies: Case studies on existing technologies and their implementation in real time environment.

**Practical :** Mobile application programming, wireless technologies, preprocessing of data and analysis using various available technologies.

**MCA-591 Seminar** **1+0**

**MCA-599 Master's Project** **0+30**

# COURSE CURRICULUM FOR B.Tech. (Agril. Engg.) 4 YEAR PROGRAMME

## Core Courses

| College of Agriculture | | Cr. Hrs. |
|---|---|---|
| Agron 102 | Principles of Agronomy | 1+1 |
| ENV 101 | Environmental studies and Disaster Management | 2+0 |
| Soils 102 | Principles of Soil Science | 1+1 |
| Hort. 203 | Principles of Horticultural Crops and Plant Protection | 1+1 |
| **College of Basic Sciences & Humanities** | | |
| Eng. 101 | General English | |
| Eng. 201 | Communication Skills and Personality Development | 1+1 |
| Phys 203 | Engineering Physics | 2+1 |
| Mgt. 201 | Entrepreneurship Development and Business Management | 2+1 |
| Chem 205 | Engineering Chemistry | 2+1 |
| Math 201 | Engineering Mathematics-I | 2+1 |
| Math 202 | Engineering Mathematics-II | 2+1 |
| Math 301 | Engineering Mathematics-III | 2+1 |
| Pbi 101/ PbiCul. 101 | Basic Punjabi / | 0+2/ |
| | Punjabi Culture | 2+0 |
| **College of Home Science** | | |
| HDFS 106 | Human Values | 1+0 |
| **College of Agricultural Engineering and Technology** | | |
| CE 105 | Soil Mechanics | 2+1 |
| CE 106 | Surveying and Levelling | 1+2 |
| CE 108 | Engineering Mechanics | 2+1 |
| CE 207 | Watershed Hydrology | 1+1 |
| CE 208 | Strength of Materials | 2+1 |
| CE 306 | Building Construction and Cost Estimation | 2+0 |
| CE 307 | Design of Structures | 2+1 |
| FMP 201 | Tractor and Farm Machinery Operation | 0+1 |
| FMP 203 | Farm Machinery and Equipment- I | 2+1 |
| FMP 302 | Tractor and Automotive Engines | 2+1 |
| FMP 306 | Farm Machinery and Equipment-II | 2+1 |
| FMP 307 | Tractor Systems and Controls | 2+1 |
| FMP 311 | Tractor and Farm Machinery Maintenance | 0+1 |
| ME 103 | Engineering Drawing | 0+2 |
| ME 104 | Workshop Technology and Practice | 1+2 |
| ME 108 | Heat and Mass Transfer | 2+0 |

| | | |
|---|---|---|
| ME 202 | Fluid Mechanics and Open Channel Hydraulics | 2+1 |
| ME 207 | Theory of Machines | 2+0 |
| ME 208 | Thermodynamics, Refrigeration and Air Conditioning | 2+1 |
| ME 302 | Machine Design | 2+0 |
| PFE 204 | Engineering Properties of Agricultural Produce | 1+1 |
| PFE 304 | Agricultural Structures and Environmental Control | 2+1 |
| PFE 305 | Post Harvest Engineering of Cereals, Pulses and Oil Seeds | 2+1 |
| PFE 306 | Post Harvest Engineering of Horticultural Crops | 2+1 |
| PFE 307 | Dairy and Food Engineering | 2+1 |
| CSE 204 | Computer Programming and Data Structures | 1+2 |
| CSE 205 | Web Designing and Internet Applications | 1+1 |
| EE 204 | Electrical Machines and Power Utilization | 2+1 |
| EE 206 | Electronics and Instrumentation | 2+1 |
| EST 201 | Fundamentals of Renewable Energy Sources | 2+1 |
| EST 301 | Renewable Power Sources | 2+1 |
| EST 302 | Bio-energy Systems: Design and Applications | 2+1 |
| SWE 201 | Irrigation Engineering | 2+1 |
| SWE 202 | Soil and Water Conservation Engineering | 2+1 |
| SWE 203 | Sprinkler and Micro Irrigation Systems | 1+1 |
| SWE 301 | Water Harvesting and Soil Conservation Structures | 2+1 |
| SWE 302 | Drainage Engineering | 2+1 |
| SWE 303 | Watershed Planning and Management | 2+1 |
| SWE 304 | Groundwater, Wells and Pumps | 2+1 |

**Project and Practical Training Courses**

| | | |
|---|---|---|
| EDT 391 | Educational Tour | 0+02 |
| IAP 491 | Industrial Attachment for Agricultural Engineering | 0+10 |
| SDT 491 | Skill Development Training in Agricultural Engineering | 0+10 |
| ELP 491 | Experiential Learning Program in Agricultural Engineering | 0+10 |
| PPR 491 | Project Planning and Report Writing | 0+10 |

## Elective Courses

Each student has to register two elective courses out of the courses listed below:

| | | |
|---|---|---|
| FMP 411 | Tractor Design and Testing | 2+1 |
| FMP 412 | Farm Machinery Design and Production | 2+1 |
| FMP 413 | Mechanics of Tillage and Traction | 2+1 |
| FMP 414 | Ergonomics and Safety | 2+1 |
| FMP 415 | Hydraulic Drives and Controls | 2+1 |
| FMP 416 | Precision Agriculture and System Management | 2+1 |
| FMP 417 | Machinery for Crop Residue and Fodder Management | 2+1 |
| FMP 418 | Farm Power and Machinery Management | 2+1 |
| PFE 401 | Development of Processed Products | 2+1 |

| | | |
|---|---|---|
| PFE 402 | Food Quality and Control | 2+1 |
| PFE 403 | Process Equipment Design | 2+1 |
| PFE 404 | Food Plant Design and Management | 2+1 |
| PFE 405 | Food Packaging Technology | 2+1 |
| PFE 406 | Waste and By-Product Utilization | 2+1 |
| SWE 401 | Floods and Control Measures | 2+1 |
| SWE 402 | Wasteland Development | 2+1 |
| SWE 403 | Information Technology for Land and Water Management | 2+1 |
| SWE 404 | Remote Sensing and Geographic Information System | 2+1 |
| SWE 405 | Design and Management of Canal Irrigation System | 2+1 |
| SWE 406 | Minor Irrigation and Command Area Development | 2+1 |
| SWE 407 | Precision Farming Techniques for Protected Cultivation | 2+1 |
| SWE 408 | Water Quality and Management Measures | 2+1 |
| SWE 409 | Landscape Irrigation Design and Management | 2+1 |
| SWE 410 | Plastic Applications in Agriculture | 2+1 |
| ME 404 | Mechatronics | 2+1 |

# SEMESTER-WISE STUDY PROGRAMME OF B.Tech. (Agril. Engg.)

## FIRST YEAR

| Semester I | | | Semester II | | |
|---|---|---|---|---|---|
| Course No. | Title of the Course | Credit Hour | Course No. | Title of the Course | Credit Hour |
| Math 201 | Engineering Mathematics-I | 3(2+1) | CE 106 | Surveying and Levelling | 3(1+2) |
| Phys 203 | Engineering Physics | 3(2+1) | CE108 | Engineering Mechanics | 3(2+1) |
| Chem 205 | Engineering Chemistry | 3(2+1) | ME 104 | Workshop Technology and Practice | 3(1+2) |
| Soils 102 | Principles of Soil Science | 2(1+1) | ME 108 | Heat and Mass Transfer | 2(2+0) |
| CSE 204 | Computer Programming and Data Structures | 3(1+2) | Agron 102 | Principles of Agronomy | 2(1+1) |
| CE 105 | Soil Mechanics | 3(2+1) | Math 202 | Engineering Mathematics-II | 3(2+1) |
| ME 103 | Engineering Drawing | 2(0+2) | ENV 101 | Environmental studies and Disaster Management | 2(2+0) |
| Pbi 101/Pbicul 101 | Basic Punjabi / Punjabi Culture | 2(0+2)/ 2+0(NC) | HDFS 106 | Human Values | 1(1+0) |
| NSS/NCC/NSO | NSS/NCC/NSO | 1(0+1)NC | Eng. 101 | General English | 2(1+1) |
| | | | | NSS/NCC/NSO | 1(0+1)NC |
| | Total<br>20(10+10)/<br>22(10+12)/<br>22(12+10) | | | Total 22(13+9) | |

**SECOND YEAR**

| Semester III | | | Semester IV | | |
|---|---|---|---|---|---|
| CE 207 | Watershed Hydrology | 2(1+1) | CSE 205 | Web Designing and Internet Applications | 2(1+1) |
| CE 208 | Strength of Materials | 3(2+1) | ME 207 | Theory of Machines | 2(2+0) |
| Hort. 203 | Principles of Horticultural Crops and Plant Protection | 2(1+1) | ME 202 | Fluid Mechanics and Open Channel Hydraulics | 3(2+1) |
| FMP 201 | Tractor and Farm Machinery Operation | 1(0+1) | EE 206 | Electronics and Instrumentation | 3(2+1) |
| Math301 | Engineering Mathematics-III | 3(2+1) | SWE 202 | Soil and Water Conservation Engineering | 3(2+1) |
| ME 208 | Thermodynamics, Refrigeration and Air Conditioning | 3(2+1) | Mgt. 201 | Entrepreneurship Development and Business Management | 3(2+1) |
| EE 204 | Electrical Machines and Power Utilization | 3(2+1) | SWE 203 | Sprinkler and Micro Irrigation Systems | 2(1+1) |
| EST 201 | Fundamentals of Renewable Energy Sources | 3(2+1) | FMP 203 | Farm Machinery and Equipment- I | 3(2+1) |
| SWE 201 | Irrigation Engineering | 3(2+1) | PFE 204 | Engineering Properties of Agricultural Produce | 2(1+1) |
| NSS/ NCC/ NSO | NSS/ NCC/ NSO | 1(0+1)NC | NSS/ NCC/ NSO | NSS/ NCC/ NSO | 1(0+1)NC |
| | Total 24(14+10) | | | Total 24(15+9) | |

**THIRD YEAR**

| Semester V | | | Semester VI | | |
|---|---|---|---|---|---|
| ME 302 | Machine Design | 2(2+0) | SWE 303 | Watershed Planning and Management | 3(2+1) |
| CE 306 | Building Construction and Cost Estimation | 2(2+0) | SWE 304 | Groundwater, Wells and Pumps | 3(2+1) |
| PFE 304 | Agricultural Structures and Environmental Control | 3(2+1) | FMP 307 | Tractor Systems and Controls | 3(2+1) |
| PFE 305 | Post Harvest Engineering of Cereals, Pulses and Oil Seeds | 3(2+1) | FMP 311 | Tractor and Farm Machinery Maintenance | 1(0+1) |
| FMP 302 | Tractor and Automotive Engines | 3(2+1) | PFE 306 | Post Harvest Engineering of Horticultural Crops | 3(2+1) |
| SWE301 | Water Harvesting and Soil Conservation Structures | 3(2+1) | PFE 307 | Dairy and Food Engineering | 3(2+1) |
| SWE 302 | Drainage Engineering | 2(1+1) | EST 302 | Bio-energy Systems: Design and Applications | 3(2+1) |
| EST 301 | Renewable Power Sources | 3(2+1) | Eng.201 | Communication Skills and Personality Development | 2(1+1) |
| FMP 306 | Farm Machinery and Equipment-II | 3(2+1) | CE 307 | Design of Structures | 3(2+1) |
| EDT 391* | Educational Tour | 2(0+2) NC | | | |
| | Total 26(17+9) | | | Total 24(15+9) | |
| *The students will register for Educational Tour in the V semester and will go on educational tour at the end of V semester during semester break. | | | **The students will register for Industrial Attachment in VII semester but the industrial attachment will start during the semester break at the end of VI semester and will carry on into the VII semester till 10 weeks are completed. | | |

**FOURTH YEAR**

| Semester VII Student READY | | | Semester VIII Student READY | | |
|---|---|---|---|---|---|
| IAP 491* | Industrial Attachment for Agricultural Engineering | 10(0+10) NC | I | Elective course | 3(2+1) |
| SDT 491** | Skill Development Training in Agricultural Engineering | 10(0+10) | II | Elective course | 3(2+1) |
| ELP 491*** | Experiential Learning Program in Agricultural Engineering | 10(0+10) | III | Elective course | 3(2+1) |
| | | | PPR 491 | Project Planning and Report Writing | 10(0+10) |
| | Total | 30(0+30) | | Total | 19(6+13) |
| * Industrial training will start in the summer break after VI semester and will continue in the VII semester either in one organization or multiple organsiations as all organizations do not absorb trainees for 8 weeks.<br>**Four compulsory modules for all the studentsSDT-1, SDT-2, SDT-3, SDT-4<br>***Each student will choose one out of four modules ELP-1, ELP-2, ELP-3, ELP-4 | | | | | |

## Skill Development Training in Agricultural Engineering (SDT 491)
## *Four Modules (all are compulsory for every student)*

**SDT-1 Geotechnical analysis of site for business establishment (1 week) – Department of Civil Engineering**

Site investigation and its importance in agricultural engineering, soil sampling, types of sampling techniques and types of samplers, standard penetration test, field tests and determination of moisture content etc, laboratory tests on samples, local laws, pollution norms, effluent treatment, construction details etc.

**SDT-2 Computer Aided Design & Applications (3 weeks) - Department of Mechanical Engineering**

Application of computers for design, Overview of CAD window: explanation of various options on drawing screen, study and practice of draw and dimension tool bar, study of OSNAP, line thickness and format tool bar, practice on OSNAP, line thickness and format tool bar, practice on mirror, offset and array commands, practice on trim, extend, chamfer and fillet commands, practice on copy, move, scale and rotate commands. Drawing of 2-D views: drawing using draw tool bar, practice on creating boundary, region, hatch and gradient commands, practice on editing polyline using PEDIT and explode commands, setting of view ports for sketched drawings, printing of selected view ports in various paper sizes. 2-D drawing of machine parts with all dimensions and allowances: drawing of foot step bearing and knuckle joint, sectioning of foot step bearing and stuffing box, drawing of hexagonal nut and bolt and other machine parts. Practice on 3-D commands: extrusion, loft, sweep, press pull, revolving, joining and other commands. Demonstration on CNC machine with simple operations, Machine drawing examples.

**SDT-3 Design and Development of Website for Engineering Entrepreneurs (2 weeks) – Department of Electrical Engineering and Information Technology**

Basic Concepts: An introduction to domain names, web servers, and website hosting, Building your first web page: The structure of an HTML page, HTML tags, HTML code examples, Introduction to website, Absolute vs Relative URL, basic layout, basic color scheme and fonts. An Introduction to CSS: Tags used in this CSS based layout, Basic concepts in Java Script programming.

**SDT-4 Campus to Corporate (1 week) – Training Unit and Placement**

Interpersonal skills, decision making, information management system, conflict management, organisational behaviour, mentoring by industry experts, market analysis, team working and leadership qualities.

**On Campus Experiential Learning program in Agricultural Engineering (ELP 491)**

***(Each student will choose one of the following)***

**ELP-1 Production of agricultural machinery using advanced techniques (7 weeks) - Department of Farm Machinery and Power Engineering**

Selection of machine (REC approved machine or machine in demand), CAD based drawings, Visit to concerned industry for an overview of manufacturing processes, Fabrication of parts using Advanced tools available in the department or in industry, assembling of the different parts, testing of the machine in the field, Visit to the customer hiring centers to check the potential of machine/product, seminar, presentation and evaluation.

**ELP-2 Agro processing and value addition of agricultural produce (7 weeks) - Department of Processing and Food Engineering**

Agricultural raw material characteristics, its procurement and storage, Site selection, plant layout, Machinery selection, Detailed project report, Unit operations in processing of wheat, paddy, pulses, oilseeds, turmeric and honey. Performance evaluation of various machines used for cleaning, grading and sorting of agricultural commodities. Quality norms/regulations. Record keeping and maintenance of machinery. Exposure of agro processing complex, Hands on training on Agro Processing Unit, packaging

and marketing of developed products from different agricultural produce from APC, Economic viability. Pre & post-harvest factors affecting quality of horticultural produce, storage methods, refrigeration, modified atmospheric. Drying of fruits and vegetables, Seminars, presentation and evaluation.

**ELP-3 Design and operation of micro irrigation systems and protected cultivation structures (7 weeks) - Department of Soil and Water Engineering**

Design, installation and operation of micro irrigation system: orientation, components, design of main, sub main, and lateral, selection of pipe and emitter, material requirements, layout, installation and operation of system. Fertigation system: fertilizers solubility, precautions while mixing fertilizers, frequency, duration and injection rate. Design and installation of protected cultivation structures: Technical standards for the construction of green/poly house structures, site selection, orientation, selection of covering material, shade net including thermal net, fogging system, profile, zig- zag spring and air circulating fans. Equipments used for installation of green, poly and shade net houses, low tunnels etc. Remote Sensing and GIS application.

**ELP-4Entrepreneurship Opportunities in Renewable Energy Sector (7 weeks) - Department of Renewable Energy Engineering**

Hands on learning of the lab scale biogas production from untreated and pretreated biomass, training on construction of Cattle dung /poultry dropping based Biogas plant, training on construction of crop residue / paddy straw based dry fermentation biogas plant, testing of Solar Photovoltaic, fabrication and Testing of Solar Thermal Gadgets, introduction to Various Thermo-chemical Conversion Processes, hands on Learning of Torification Process, Pyrolysis Process and Charcoal Making Process, hands on Learning of the Pellets and Briquetting Process, an Introduction to liquid biofuels and hands on experience of biodiesel preparation from plant oils at laboratory scale, energy Management and Auditing.

**Students who do not opt Basic Punjabi and Punjabi culture**

| Semester | Credit hours including NC | Theory | Practical | NC |
|---|---|---|---|---|
| Sem 1 | 20 | 10 | 10 | 1 NC |
| Sem 2 | 22 | 13 | 9 | 1 NC |
| Sem 3 | 24 | 14 | 10 | 1 NC |
| Sem 4 | 24 | 15 | 9 | 1 NC |
| Sem 5 | 26 | 17 | 9 | 2 NC |
| Sem 6 | 24 | 15 | 9 | |
| Sem 7 | 30 | 0 | 30 | 10 NC |
| Sem 8 | 19 | 6 | 13 | |
| Total | 189 | 90 | 99 | 16 NC |

**Students with Basic Punjabi**

| Semester | Credit hours including NC | Theory | Practical | NC | |
|---|---|---|---|---|---|
| Sem 1 | 22 | 10 | 12 | 3NC | |
| Total | 191 | 90 | 101 | 18 NC | |

**Students with Punjabi Culture**

| Semester | Credit hours including NC | Theory | Practical | NC |
|---|---|---|---|---|
| Sem 1 | 22 | 12 | 10 | 3NC |
| Total | 191 | 92 | 99 | 18 NC |

SECTION X

# FACULTY OF COMMUNITY SCIENCE

## General Information

### Disciplines

- Apparel and Textile Science
- Fashion Designing
- Extension Education and Communication Management
- Food and Nutrition
- Nutrition and Dietetics/Food Nutrition and Dietetics
- Human Development and Family Studies
- Resource Management and Consumer Science
- Course Curriculum for B.Sc. (Hons.) Community Science 4 Year Programme
- Course Curriculum for B.Sc. (Hons.) Fashion Designing 4 Year Programme
- Course Curriculum for B.Sc. (Hons.) Nutrition and Dietetics/ Food Nutrition and Dietetics 4 Year Programme
- Course Curriculum for Certificate course in Early Childhood Care and Education 1 Year Programme
- Course Curriculum for Certificate Course in Interior Design and Decoration 1 Year Programme.

# COLLEGE OF COMMUNITY SCIENCE

The College of Community Science formerly known as College of Home Science was established to cater to the need of empowering women, to contribute to family economy and improve their quality of life. Home Science/Community Science is an inter-disciplinary field of knowledge which integrates concepts from Physical, Biological, Agricultural, Social and Environmental Sciences along with its own components of Apparel and Textile Science, Extension Education and Communication Management, Food and Nutrition, Human Development and Family Studies and Resource Management and Consumer Science. It prepares the individuals to obtain recent scientific information for dealing with real life situations to cope up with everyday problems effectively by providing broad-based, culturally relevant knowledge in different areas of Community Science.

The need of Home Science Colleges as a part of State Agricultural Universities emerged with an increase in awareness of contribution of rural and urban women to family economy and in raising the standard of living. Punjab Agricultural University started the College of Home Science in July, 1966 under the guidance of two experts in Home Science namely Dr. Edna R Kaufman and Dr. Maria S Friesen who were members of USAID team to PAU. Through its integrated programme of teaching, research and extension, the College grew rapidly, playing a significant role in improving the socio-economic conditions of rural as well as urban families, thereby, giving them opportunity to have a better quality of life.

Mrs Sushila Dantyagi, a renowned Home Scientist, was the founder Dean of the College who was at thehelm of affairs till August, 1973. The other successive regular Deans of the College were: Dr (Mrs) S Bajaj, Dr (Mrs) P L Srivastava, Dr (Mrs) M B Singh, Dr (Mrs) K K Sharma, Dr (Mrs) S K Mann, Dr (Mrs) M K Dhillon, Dr (Mrs) N Grewal, Dr (Mrs) J K Sangha, Dr (Mrs) J Kishtwaria, Dr (Mrs) J K Gulati and Dr (Mrs) S Bains. Dr. (Mrs) K Bains took over as Dean of the College in November, 2023.

The College offers three degree programmes at the undergraduate level i.e B.Sc. (Hons) Community Science 4-year programme after 10+2, B.Sc. (Hons.) Fashion Designing 4- year programme which was initiated in the year 2008 and B.Sc. (Hons.) Nutrition and Dietetics 4-year programme which was initiated in the year 2009 and in academic session 2024-25, the nomenclature has been changed to B.Sc. (Hons.) Food Nutrition and Dietetics 4-year programme. The College has also started two certificate courses of one year duration each from academic session 2024-25. These are certificate course in Early Childhood Care and Education and Certificate Course in Interior Design and Decoration. The College is a pioneer institution among the Home Science Colleges of State Agricultural Universities that started offering Masters' programmes in all the disciplines of Home Science in the seventies. The Doctoral programmes in Food and Nutrition and Family Resource Management were introduced in the years 1974and 1978, respectively. As the discipline grew, the Ph.D. programmes were initiated in other departments as well- Extension Education and Communication Management in 1986-87, Human Development and Family Studies in 1997-98 and Apparel and Textile Science in the year 1998-99.

There had been changes in the nomenclature of various departments from time to time. The Department of Child Development was renamed as 'Department of Human Development' in the year 1998. Department of Home Management got it's new name 'Family Resource Management' in 2000. Department of Home Science Extension Education was rechristened as 'Department of Home Science Extension and Communication Management' in 2010. The Department of Clothing and Textiles was renamed as 'Department of Apparel and Textile Science' in 2013.

As per the recommendation of Fifth Dean's Committee and BSMA, the nomenclature of various departments was changed again. In 2016, the Department of Human Development was renamed as 'Department of Human Development and Family Studies' and Department of Home Science Extension and Communication Management as 'Department of Extension Education and Communication Management.' In 2023, The Department of Family Resource Management was rechristened as 'Department of Resource Management and Consumer Science.' The name of B.Sc. (Hons) Home Science Degree was changed to 'B.Sc. (Hons) Community Science' in 2016-17. The College of Home Science was retitled as 'College of Community Science' in the year 2019-20.

Since the inception of the College, need based revision of course curriculum has been undertaken periodically to cater to the emerging scenario in the discipline. The Vth Deans' committee of the ICAR has recommended change in the syllabi of various UG programmes being run by SAUs with a view to orient these

towards emerging needs of respective disciplines and the educational scenario. The course curriculum of B.Sc. (Hons) Community Science 4-year degree programme has been restructured in the light of these recommendations, without deviating from the main mission of the programme. Under the restructured curriculum, the students are required to take specialization/ professional courses in one of the specific disciplines of Community Science in the last year. These courses are vocational in nature and provide practical training in self-employment/ entrepreneurship. In the last semester, Experiential Learning and In plant Training of the students has been planned to hone their entrepreneurial skills and enable them to start their own enterprises. The students also undertake Rural Awareness Work Experience in this semester.

The curricula of Masters' and Ph.D. programmes in all the disciplines was restructured in 2010-11 in accordance with ICAR guidelines and again restructured and revised according to Broad Subject Matter Area (BSMA) Committee recommendations. The present curricula aims at increasing both the academic as wellas vocational capabilities of the students for better employability.

The College has the privilege of having one of the best-equipped laboratories amongst the Community Science Colleges of the country. There are good number of class rooms, seminar rooms and laboratories in the College. To facilitate the teaching of highly vocational professional electives, several additions have been made to the existing laboratories. These include Baking, Institutional Management, Multimedia, Computer and ARIS laboratories. The College also has four Experiential Learning Units, one each on Apparel Manufacturing, Artistic Creations, Bakery and Confectionary and Early Childhood Care and Education. Laboratories are regularly updated with latest equipment to impart quality education both at UG and PG level.

# APPAREL AND TEXTILE SCIENCE

## PROGRAMMES

1. **B.Sc. (Hons.) Fashion Designing**
2. **M.Sc.**
3. **Ph.D**

## COURSE REQUIREMENT

### M.Sc.

| | |
|---|---|
| Fields of specialization | Apparel, Textiles |
| Required courses | ATS-501, ATS-502, ATS-503, ATS-504. |
| Supporting courses | Stat.-502 and Ext.-504 or other courses from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Minor field | Food and Nutrition, Extension Education and Communication Management, Resource Management and Consumer Science, Human Development and Family Studies, Business Management, Sociology, Chemistry or any other as approved by the Dean, Postgraduate Studies. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

### Ph.D.

| | |
|---|---|
| Fields of specialization | Apparel, Textiles |
| Required courses | ATS-601, ATS-602, ATS-605 |
| Supporting courses | A student can opt any course related to the topic of research offered by other faculties of Agriculture University or SWAYAM portal or other online courses up to a maximum of 5 credits. |
| Minor field | Food and Nutrition, Extension Education and Communication Management, Resource Management and Consumer Science, Human Development and Family Studies, Business Management, Sociology, Chemistry or any other as approved by the Dean, Postgraduate Studies. |
| Deficiency courses | As recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**ATS 101 Fundamentals of Clothing Construction 1+2 Sem. I**

Importance and functions of clothes. Terminology related to clothing construction. Sewing tools and equipments required for measuring, drafting, cutting and stitching. Selection and preparation of fabric for garment construction. Layout of paper pattern, marking, cutting and stay stitching. Unit construction method. Socio-economic and psychological factors affecting clothing choices. Consumer behaviour and motivation. Clothing requirements of different age groups: infant, toddler, pre-schooler, school age children, teenager, adolescent, adult and senior citizen. Application of elements and principles of art in apparel designing.

**Practical:** Demonstration on sewing equipments and tools, sewing machine and its care. Preparation of samples - hand stitches, basting, slip-stitching, hemming, smocking, overcasting, attaching fasteners and button holing, mending and patching. Machine stitches-seam and seam finishes, pleats, gathers and tucks, stay stitch, under stitching and placket opening. Demonstration on taking body measurements. Preparation of fabric for cutting and layout of paper pattern on different fabrics, patterns including plain, print, lines, plaid and check. Drafting, cutting and stitching of petticoat, bloomer and baby's frock.

**ATS 102 Textile Science and Fabric care 2+1 Sem. II**

Importance of textile industry in national economy. Terminology, forms of textiles. Properties of textile fibres - primary and secondary. Classification of textile fibres. Chemical composition. Orientation of fibres. Cotton, Flax, Jute, Wool, Silk - fibre production, varieties and their grading, morphology, physical, chemical and biological properties and end-uses. Introduction to hemp and ramie. Man-made and synthetic fibres – Rayon, Diacetate and Triacetate, Nylon, Polyester and acrylic - manufacturing, microscopic structure, physical, chemical and biological properties and end-uses. Spinning of natural and man-made fibres. Classification of yarns on the basis of structure - simple and novelty, twist direction, twist amount fibre length and end uses. Important yarn properties. Methods of fabric construction- weaving, knitting, braiding, tufting, netting, lace making, crocheting, macramé, stitch through fabrics, quilting, lamination, bonding, felting, nonwovens and films. Stain removal- classification, principle and methods of removal. Laundry - definition, principles, equipment, methods and dry cleaning. Laundry agents- water, soap. Laundry auxiliaries- stiffening agents, bleaches and blues. Care of textiles. Labeling and Labeling Act. Labels and tags used in textiles. Storage of clothes - requirements of short and long term storage.

**Practical:** Testing of textile fibres - microscopic, burning, solubility and visual inspection. Identification of different types of yarns, fabric samples of different thread count and construction. Removal of different stains from fabric surface. Washing and finishing of garments made from cotton, wool, silk, blends/ synthetic. Folding and packaging of clothes. Collection of different labels. Visit to a textile industry.

**ATS 201 Techniques of Fabric Construction 2+1 Sem. I**

Fabric construction – Introduction and methods. Weaving terminology. History of weaving and looms. Characteristics of woven fabric. Classification, parts and working of looms. Loom mechanics and weft insertion. Loom accessories and their functions. Principles and mechanism of weaving - primary, secondary and tertiary motions. Basic weaves- plain, twill and satin and their variations. Complex weaves: extra yarn fabrics- pile, lappet, swivel; leno, damask, dobby and jacquard. Knitting terminology. History and principle of knitting. Knitting machines- parts and their functions. Types of knitting machines. Stitches used in knitting - plain, rib and purl. Types of knitted fabrics and their characteristics. Non-wovens : construction, properties, types and end uses. Felting - manufacturing process, characteristics of felt and end uses. Macramé and crochet- tools and materials, construction, properties and end uses.

**Practical:** Analysis of fabric structures using a magnifying glass. Graphical representation of woven designs. Identification of parts of the loom. Weaving calculations. Yarn preparation for plain weave. Setting of loom and weaving of plain weave samples. Types of knitting machines and its parts. Sample

preparation using different hand and machine knitting techniques. Construction of macramé and crochet samples. Visit to weaving, knitting and felting industrial units.

**ATS 202 Garment and Accessory Designing** **0+3** **Sem. II**

Anthropometry -importance and techniques. Selection of figure template for men, women and children. Designing of women's garments using different construction features- collars, sleeves, necklines and yokes; men's garments using different collars, sleeves, cuffs and yokes; children's garments using different gathers, pleats, tucks, yokes, shirring, smocking and trimmings. Drafting and construction of selected garments for women, men and children- fancy frock, *salwar/ pyjama/ pyjami*, *kurta* (gents)/ *kameez* (ladies), night dress/ gown. Classification of accessories - footwear, hand bags, belt, jewellary, gloves, hats, scarves and umbrella. Designing of accessories for women, men and children**.** Selection of design and construction of one accessory each for women, men and children.

**ATS 301 Textile Finishes** **2+1** **Sem. I**

Textile finishing- definition and its importance. Classification of textile finishes- chemical and mechanical; performance finishes-durable/ permanent /non-renewable and temporary/ renewable/surface/semi-permanent; reactive and additive, aesthetic/basic and functional. Processes of removing impurities from fabrics - scouring, desizing, degumming and carbonizing. Purpose and application of different finishes - fulling / milling, felting, singeing, stiffening, decatizing, bleaching, delustering, calendering, beetling, napping, flocking, devore, parchmentization, plisse finishing, tentering, shearing, brushing, water proofing, water repelling, shrinkage control, wrinkle resistance, anti-static, anti-microbial, durable press and flame retardant finish. Dyes and pigments. Application and classification of dyes- direct, acid, basic, vat, azoic/napthol, mordant, sulphur, reactive, disperse and natural dyes. Dyeing equipment and techniques - solution dyeing, fibre dyeing, tow and stock dyeing, yarn dyeing, skein and package dyeing and piece dyeing. Styles of printing- direct, discharge andresist printing. Printing equipment and methods - block, screen, stencil, roller, discharge, heat transfer printing, batik and tie and dye.

**Practical:** Finishing of cotton fabric- scouring, bleaching, mercerization. Tying and dyeing ofcotton fabric with direct dyes. Fabric designing by batik technique using azoic/napthol dyes. Printing of cotton fabric using different methods – block, stencil, screen, discharge and heat transfer. Visit to dyeing and printing unit.

**ATS 302 Traditional Textiles of India** **2+1** **Sem. II**

Traditional textiles of India – Introduction, importance and market scenario. Geographical indications obtained for traditional Indian textiles. History of woven textiles- Dacca muslin, brocades, traditional *sarees* of India - *Jamdani, Baluchari, Pochampalli, Patola, Ikat*, *Kanjivaram, Chanderi, Maheshwari, Bomkai, Sambhalpuri, Vichitrapuri, Paithani, Kota doria, Gadwal, Irkal, Venkatagiri*, *Narayanpet, Kasavu, tanchoi* and brocade *sarees*. Traditional woven and embroidered shawls of Kashmir, Himachal Pradesh, Gujarat, North Eastern and other states. Printed textiles- calico printing, block printed textiles - *Dabu, Bagru, Sanganeri* and *Bagh* printing. Tie and dyed textiles. Painted textiles- *kalamkari, Madhubani, Warli, Patchitra, Phad and Pichhavai.* Embroideries of different states of India- *kashida, Chamba rumal, chikankari, zari* work, *phulkari* and *bagh*, *Kathiawad*, *kantha*, *kasuti, Rabari, Pipli,* Kutch and Manipuri embroidery. Introduction to costumes of India.

**Practical:** Documentation of motifs and preparation of samples of traditional Indian embroideries. Documentation of woven textiles of India. Adaptation of traditional motifs and designs to contemporary textiles through collection of samples, sketches and development of scrap book. Visit to museums and art gallery.

**ATS 303 Retailing and Merchandising – Textiles and Apparel** **2+0** **Sem. II**

Retailing and merchandizing concept, terminology and principles. Factors affecting merchandizing. Role and responsibilities of merchandiser. Merchandizing for buying houses, departmental stores and export houses. Evolution of retail and retail formats – specialty stores, chain store, factory outlets, temporary outlets, discount stores, and warehouse clubs. Malls – introduction, components and types- neighborhood, community, regional, superregional and outlet malls. Marketing research- meaning, scope, classification and steps in marketing research. Role of marketing research in product planning. Methods and techniques

of sale promotion personal selling, publicity, advertizing and visual display. Promotion mix and 7 Ps' of marketing. Pricing methods and pricing of textiles. Export and import- introduction to policies, procedures and organizations. WTO and its functions.

**ATS 401 Seminar** **1+0** **Sem. I**

**ATS 402 Experiential Learning-I Computer Aided Designing and Pattern Making** **0+8** **Sem. I**

Introduction to geometric and fleshed twelve head figure- manual and computerized. Introduction to tools of fundamental designing softwares. Detailed use of smart drawing tools. Designing and draping garments on croquis. Colouring the draped garments using interactive tools. Creating shades in dress with interactive fill and mesh tools. Creating effects in various silhouettes. Drafting of an adult bodice block. Designing of shirts, jackets and skirts using selected necklines, yokes, collars, sleeves, pockets and accessories. Introduction to pattern making software. Basics of pattern making tools. Creating and grading basic patterns. Bodice front and back, sleeves, skirt front and back. Designing and styling using flat pattern technique. Moving, dividing and combining darts- pivot and slash method. Converting darts into seam lines. Adding fullness by gathers, pleats and tucks. Construction of different types of yokes, collars and sleeves.

**ATS 403 Experiential Learning – II Manufacturing of Life Style Products** **0+12** **Sem. I**

Identification and designing of products to be manufactured. Market Survey and need assessment. Analysis of existing status of identified products and targeted market and customers. Execution of the plan and product development.

**ATS 412 Internship I /Entrepreneurial placement / In plant Training** **0+8** **Sem. II**

Training of the students in hosiery or ready-made garment industrial unit to develop industry oriented skills and impart Practical experience in actual work environment.

**ATS 413 Internship II/ Project Report and Presentation** **0+2** **Sem. II**

Training of the students to identify the problem, develop tools to collect data, analyze and interpret the data. Report writing and presentation.

## Postgraduate courses

**ATS-501 Textile Chemistry** **2+1** **Sem. I**

**Unit I** Chemistry of polymers

Polymerization- types, degree and characteristics; Structure of textile fibres- molecular bonding, length, orientation; Requirements of fibre forming polymers; Bi-component and Bi-constituent fibres- types, characteristics, application and spinning (fibre forming systems).

**Unit II** Structure-property relations of natural fibres

Repeating units, bonds, reactive groups; Reactions of cotton, linen, jute, silk, wool, and minor natural fibres to, heat, light, various chemicals and microorganisms.

**Unit III** Structure-property relations of Man-made and Synthetic fibres

Repeating units, bonds, reactive groups and reactions of viscose rayon, modal (HWM), polyester, nylon, acrylic, spandex to heat, light, various chemicals and microorganisms; Fibre Blending principles, types and scope.

**Unit IV** Introduction to high performance fibres

Aramid, Ultra-High Molecular Weight Polyethylene (UHMWPE), High Density Polyethylene. (HDPE), Carbon, Fibres with Limited Oxygen Index (LOI), Glass and Specialty fibres.

**Practical** : Preparation of chemical solutions for fibre testing. Fibre testing – Natural fibres- cross sectional view of cotton, jute, linen, wool and silk. Cross sectional view of Man-made fibres – Viscose, polyester, acrylic and minor fibres. Effect of heat on cellulosic, protein and synthetic fibres. Effect of dilute and conc. acids on cellulosic, protein and synthetic fibres. Effect of dilute and conc. alkali on cellulosic, protein and synthetic fibres. Detection of acid damage on cotton. Mercerization of cotton fibres and

yarns- with and without tension. Effect of bleaching on textile fibres – Detection of damage due to over bleaching. Effect of finishing agents and solvents on cellulosic, protein and synthetic fibres. Detection of damage to cellulosic and protein fibres by acids and alkalies. Quantitative analysis of binary fibre blends and conditioning and estimation of fibre blend ratio. Quantitative analysis of tertiary fibre blends and conditioning and estimation of fibre blend ratio.

**ATS-502 Textile and Apparel Quality Analysis** **2+1** **Sem. II**

**Unit I** Quality analysis and control

Importance of quality analysis and control; Effect of moisture and humidity on properties of textiles; Standard conditions of testing; Sampling – methods and techniques for fibre, yarn and fabric.

**Unit II** Fibre and yarn testing

Fibre testing - length, linear density, maturity and strength; Yarn testing – yarn count, single and lea strength, twist, crimp and evenness.

**Unit III** Fabric testing

Fabric testing – Geometrical properties - thread count, weight, thickness, strength - breaking, tearing and bursting; Abrasion resistance, pilling, crease recovery, stiffness, drapability, air permeability, thermal properties, flammability, water absorbency and repellency, dimensional stability, colour fastness; Comfort and fabric handle measurement.

**Unit IV** Apparel Quality Control

Yarn and fabric defects; Preliminary inspection- Quality specifications and standards in raw material purchasing – fabric and accessories; In-process inspection - Quality control in spreading, cutting and bundling products; Quality factors in sewing, pressing, folding and finishing; Quality aspects of trims and accessories; Tolerance limits for garment dimensions; Final inspection – general garment defects; Procedure for quality checking and reporting.

**Unit V** National and International organizations for standards

National and international organizations for standards – BIS and other global standards; Quality auditing system – process and product audit, internal quality audit procedure.

**Practical:** Sampling techniques of fibre, yarn and fabric. Testing of fibre – length, maturity and linear density. Yarn Testing – count, twist, crimp and evenness. Fabric testing – Geometrical properties - weight, thickness and fabric count. Fabric testing – abrasion resistance, pilling, crease recovery, stiffness, drapability, air permeability, thermal properties, water permeability, wicking and dimensional stability. Breaking Strength– tensile strength of fibre, yarn and fabric. Estimation of tearing and bursting strength of fabrics. Processing, statistical analysis of the test data and interpretation of results. Garment Quality - Inspection of raw materials and analysis of defects in raw materials. Product quality analysis with respect to specification sheets- raw materials, product dimensions, construction and labelling. Study of quality auditing system in the industry. Quality analysis of low priced, medium priced and high-priced garments available in market – fabric quality, workmanship, fitting and sizing. Visit to a textile testing laboratory.

**ATS-503 Pattern Making and Draping** **1+2** **Sem. I**

**Unit I** Advanced techniques of pattern making and draping

Advanced techniques of pattern making and draping: incorporating style lines and fullness.

**Unit II** Contouring

Contouring – principles, contour guide patterns, classic, empire, surplice, off-shoulder designs, halters.

**Unit III** Bodice - Sleeve variations

Raglan sleeve variations – one-piece raglan, deep armhole raglan, armhole-princess raglan, yoke raglan with bell sleeve; drop shoulder, exaggerated armholes, *kaftan*.

**Unit IV** Pattern Grading and Fitting

Pattern grading – principles, grading bodice, sleeve, collar. Fitting – principles, standards, fitting problems and remedies.

**Practical** : Dart manipulation through pivotal transfer and slash and spread method. Methods of adding fullness and contouring. Developing designs with added fullness and contouring using darts, pleats, tucks & gathers. Contouring -application in classic and empire designs, off-shoulder designs, halter neckline designs and surplice designs. Draping of dartless shirt designs. Incorporating style lines. Draping collars, cowls at neckline and underarm and in skirts. Draping built-in necklines, flounces, ruffles and peplums. Draping designs with knit fabrics and making patterns. Pattern making for variations in sleeves, variations in skirts and variations in trousers. Pattern grading- bodice and sleeves. Pattern grading of skirts; men's and women's garments. Designing garment 1, 2 and 3 based on both the methods of pattern making and draping and making patterns. Construction of custom garment 1, 2 and 3. Assessment of custom garments for quality and body fit.

**ATS-504 Woven Textile Design** **2+1** **Sem. II**

**Unit I** Types of looms, scope and importance

Shuttleless looms –scope, importance and types -projectile, rapier, air jet, water jet weaving; multiple shed loom; Circular weaving; Tri-Axial looms; Pre-weaving processes for advance weaving; Automation in weaving.

**Unit II** Woven designs and various weaves

Woven Design – fabric textures; Graphical representation of design, draft and peg plan; Classification of weaves; Warp weight and weft weight calculations; Twill weave and its modification; Colour and weave effects.

**Unit III** Types of textured and decorative weaves

Construction of crepe, toweling- honeycomb, huck-a-back, bedford cord and curtain weaves, mock leno; Construction and production of complex structures - leno, double cloth, extra warp and extra weft figuring, terry pile and velveteens.

**Unit IV** Specialty fabrics

Construction and production of damask and brocade fabrics using jacquard patterning devices; Methods of carpet making; Use of specialty fibres, specialty yarns, designing and production of specialty fabrics.

**Practical** : Weaving introduction – Procurement of yarn, setting up loom. Analysis of woven samples from different weaves. Construction of design, draft and peg plans for different weaves. Weaving samples of basic weave variations- plain and satin. Weaving samples of basic twill weave variations. Developing woven designs for weaving. Motif preparation and placement in different styles. Developing colour and texture plans. Weaving of the fabric with woven designs. Documentation of traditional textile designs. Development of modified textile designs. Documentation of modified textile designs. Visit to modern weaving mill with shuttle less looms. Portfolio development with woven samples and created designs.

**ATS-505 Wet Processing of Textiles** **2+1** **Sem. II**

**Unit I** Chemistry of dyes and pigments

Theory of dyeing; Chemistry of dyes and pigments- composition, structure, properties, affinity towards fibres, method of application, fixing, after treatments and fastness properties; Dyeing with natural dyes and role of mordants.

**Unit II** Advanced Dyeing and Printing Techniques

Dyeing of blends; Advanced dyeing techniques – macro, micro and nano; Dyeing machines used at the cottage and industrial level for fibre, yarn and fabric; Dyeing and printing defects and remedies; Advanced printing techniques- digital printing, 3D prints, automated flat bed and rotary screen printing; Assessment of colour fastness.

**Unit III** Textile Finishes

Textile finishes – concept, scope and importance ; functional finishes on different fabrics – antimicrobial, soil and stain release, durable press, UV protective, flame retardancy ; Comfortimparting finishes - application, uses, characteristics, problems and evaluation; Finishing with enzymes; Finishing of blended fabrics.

**Practical** : Preparation of fabrics for dyeing, for printing and for finishing. Developing shade cards on different substrate with various classes of dyes and colour matching. Natural dyeing. Dyeing with use of different mordants. Advanced techniques of fabric printing. Identification and application of finishing agents. Eco-friendly finishing of textiles. Assessment of properties of finished fabrics. Study of labels pertaining to finishes. Theme based project work –theme selection and project preparation.

**ATS-506 Computer Aided Textile and Apparel Designing** **0+2** **Sem. II**

CAD commands. Textile designing softwares. Creation of textile designs (2D and 3D). Application of textile designs for different end uses. Creating stripes and checks using various commands. Creating a weave library. Assigning weaves to the designed stripes and checks for weaving. Introduction to commands from different tool groups- file menu, freehand, geometric, selection, selection utility, colour utilities and general utilities and practicing on these tools. Developing motifs by scanning and drawing using the CAD commands. Creatingfull design/ repeat using drop devices. Creating weaves and storing in Jacquard weave library. Assigning weaves to the design plan. Learning print commands- simulation and graph/ point paper. Developing a computer aided portfolio of different motifs. Introduction to different software - command bars and assistants, menu bar and options, drawing tools. Colour rendering; fill, pattern and repeat tools. Creation of special effects layers and layer settings. Apparel pattern making modules. Development of basic pattern through CAD. Principles of pattern making and basic blocks. Adaptation of styles. Fundamentals of grading and marking. Introduction to draping mode. Outlining, creation of grid and editing the object. Draping scanned pictures. Texture mapping and creating effects. Development of library and printing designed patterns. Preparation of portfolio of developed designs. Product designing and development of trims, foot wears, hand bags, buttons, buckles, belts, hats, scarf and jewellery.

**ATS-507 Textile and Apparel Industrial Management** **3+0** **Sem. II**

**Unit I** Indian Textile industry

Textile industry- history, development and status; export and import policies of Government; Textile research associations; Textile crafts councils.

**Unit II** Status of garment industry in India

Status of garment industry in India-production, marketing, distribution, consumption and export trends over last five years; problems of apparel industry and remedial measures. Complexity of management in garment industries: objective and expectations.

**Unit III** Management in Apparel industry

Classification of apparel industry- large, medium, small and role of MSMEs; Infrastructural facilities and personnel management in apparel industry; Techniques in managerial application of cost volume profit analysis; Productivity analysis, case studies.

**Unit IV** Trade related organizations

Apparel parks, apparel export promotion council, National fashion and design institutes; GATT, TUF, ISO 9001:2015, 14001:2015 and 26000:2010 standards; WTO and its impact on textile and apparel industries; Effect of trade globalization on apparel industry.

**Unit V** Automation in apparel and textile industries

Recent advancements in CAD/CAM applications; automation in the industry; role of roboticsin productivity management

**ATS-508 Historic Textiles and Costumes** **1+1** **Sem. II**

**Unit I** Study of traditional textiles

Study of traditional dyed, printed, embroidered and non-woven textiles in terms of fibre content, fabrics,

motifs, colours, designs and dyes used in Egypt, Greece, Rome, France, America, Japan and China.

**Unit II** Study of traditional costumes

History and evolution of traditional costumes and accessories for men and women of Egypt, Greece, Rome, Japan, France, America and China.

**Practical** : Collection and documentation of traditional textile prints and surface designs of Egypt & Greece, Rome & France, America & Japan and China. Developing textile surface designs with combination of motifs of different countries. Documentation of various styles of men's garments and women's garments of various countries. Designing and adaptation of outfits for men and women from historic costumes according to current trends. Visit to museums and reporting and presentation of the visits.

**ATS-509 Textile Auxiliaries** **2+1** **Sem. I**

**Unit I** Introduction to auxiliaries

Textile auxiliaries– definition, classification, selection and uses in processing operations.

**Unit II** Surface active agents

Chemistry and synthesis of surface-active agents - essential requirements of surfactants, classification and biodegradability; Physical principles of cleansing efficiency; Scouring, bleaching and mercerizing auxiliaries.

**Unit III** Dyeing and Printing auxiliaries

Dyeing auxiliaries - Wetting, levelling, stripping, dye fixing, swelling, dispersing agents and carriers; Printing auxiliaries – thickeners and their classification, wetting, hygroscopic, antifoaming, reducing, oxidizing agents and pigment binders, fixers and miscellaneous auxiliaries.

**Unit IV** Finishing auxiliaries

Stiffening, cross linking, optical brighteners, softeners, water proof/repellents, flame proof/retardants, soil release, anti-pilling, antimicrobial, moth and mildew proofing; methods of producing nanoparticles of auxiliaries for textile finishing.

**Practical** : Market survey of different textile auxiliaries. Analysis of the surfactant properties of surfactant 1 and surfactant 2. Preparation of detergent. Preparation of sizing combination 1 and combination 2. Analysis of the sized samples. Selection of suitable combinations. Assessment of whiteness index of fabrics finished with bleach 1 and 2. Assessment of whiteness index of fabrics finished with optical brightening agent 1 and 2. Assessment of whiteness index of fabrics finished with detergent 1 and 2.

**ATS-510 Socio-Psychological Aspects of Clothing** **2+0** **Sem. II**

**Unit I** Clothing

Clothing-origin, theories, functions and modern philosophy of clothing in relation to culture; Clothing symbolism; Factors effecting clothing fashion, fad, custom, tradition, culture contact, status, age, education, technology and role of legislation.

**Unit II** Socio-psychological aspects of clothing

Socio-psychological aspects of clothing-first impression, individual values, interest, attitude, motivation in clothing choices, self-respect, self-enhancement, self-expression, gender desirability and individuality; clothing and society: clothing and social behaviour, influence of religion, beliefs, customs and traditions; clothes and conformity; cloths and occupation; socio psychological impact of clothing among different age groups; significance of uniforms and national costumes. Clothes for conformity, mobility, aesthetic appearance. Health and sanitation related to clothing.

**Unit III** Consumer behaviour

Consumer behaviour: concept and importance, consumer needs and motivations, consumer perspective and viewpoints; environmental influence; individual differences. Consumer resourses: involvement and motivation; knowledge, attitudes; individual differences inbehaviour; psychological processes. Consumer decision-making processes; model of consumer decision-making; consumer analysis and marketing

strategy; retailing; consumer trends; market segmentation; diffusion of innovation; Counterfeit textiles and consumer protection measures; consumerism and role of media.

**Unit IV** Marketing concept

Marketing concept; Types of customers; Understanding consumers and customer demand; Market segmentation and consumer adopter categories their characteristics, psychographics and the interrelationship with production, price zones and marketing strategies in relation to fashion cycle; Theories of fashion adoption; Role of fashion influencers.

**ATS- 511 Sustainability in Textile and Apparel Industry** **2+0** **Sem. I**

**Unit I** Impact of textile sector on environment

Environmental threats in textile and apparel industry- raw materials and processes; Banned dyes and chemicals in India; Concept of green supply chain; Certified organic, renewable and low impact raw material; Reduced toxicity in fiber processes and treatments; Effluent Treatment Plants; Concept of zero wastage and lean manufacturing; Pre consumer and post-consumer textile wastage; 3-R approach and its advantages; Environmental friendly packaging and eco labeling; Certified agencies imparting eco label.

**Unit II** Natural dyes

Natural dyes – importance, classification of natural pigments; extraction methods includingthe concept of supercritical dyeing, microwave and ultrasonication, mordants and dyeing methods; Role of natural dyes in safeguarding the environment.

**Unit III** Reduced energy processes

Reduced energy processes; Use of alternative sources of energy during product lifecycle; Importance of carbon credits in textile and apparel manufacturing.

**ATS-512 Textile and Apparel Product Development** **1+1** **Sem. II**

**Unit I** Textile and apparel product development

Textile and apparel product development – concept, history, objective; product design, product life cycle and new product development. Merchandising – role, responsibilities,use of calendar, branding, labelling and retailing.

**Unit II** Product testing

Product – testing, economics, standards and specifications; product quality control; technical services, positioning and marketing.

**Unit III** Organizational behaviour

Organizational behaviour; accounting; product intellectual property law.

**Unit IV** Commercial product development

Commercial product development - Role of computers and related software in product development. e-marketing – concepts and application.

**Practical** : Product review- Analyzing existing products of textile in terms of design, life cycle and assessment of market need for new product development. Development of survey performa for preparation of product profile of textile product-1 and 2. Development of survey performa for preparation of product profile of apparel product-1 and 2. Survey on selected products from textiles and apparel field. Product testing and analysis of selected textiles – quality, serviceability, material, construction, performance, products standard, specifications and cost. Product testing and analysis of selected apparels– quality, serviceability, material, construction, performance, products standard, specifications and cost. Product planning on the basis of market needs, aesthetic, functional requirements and producibility. Productionof new product with aesthetic, functional requirements and producibility. Project work.

**ATS-513 Laboratory Techniques in Textile Research** **0+2** **Sem. I**

Preparation of buffers, reagents and standard solutions for pre-processes. Demonstration on Microencapsulation– preparation and application; assessment through TEM, SEM and FTIR. Demonstration on Nano synthesis – preparation and application; assessment through TEM,SEM and FTIR. Optimization of variables for various dyes, various printing, various finishing treatments and for various enzyme treatments. Analysis of water- pH, TDS. Analysis of dye extracts. Analysis of finishing extracts. Analysis of water-dye effluents, BOD, COD, anions, cations. Laboratory techniques for assessing colour strength, reflectance, spectrophotometry- visible, ultraviolet, infrared and chromatographic techniques. Use of different scales to assesslight fastness, washing fastness and rubbing fastness. Management and interpretation of data generated. Statistical analysis of test results in SPSS package.

**ATS-514 Special Project** **0+1** **Sem. II**

**ATS-591 Seminar** **1+0**

**ATS-599 Master's Research** **0+30**

## Ph.D. courses

**ATS-601 Textile Ecology** **2+0** **Sem. I**

**Unit I** Textile ecology

Textile ecology – concept and importance; Industrialization, eco-balance and sustainability;Air, noise and water pollution by mechanical and chemical textile processing units and their effect. Organic and coloured cotton, natural dyes and detergents.

**Unit II** Treatment and disposal of textile effluents

Particulate matter and pollution control devices; Treatment processes of sewage. Waste minimization and management strategies; Recovery and reuse of water and chemicals.

**Unit III** Banned dyes and chemicals used in textile industries

Banned dyes, heavy metals, pesticides and auxiliaries in textile and related industries. Health hazards of textile workers and their remedial measures; Colour removal technologies.

**Unit IV** Indian and International environmental legislations

Indian and international environmental legislations. Eco-standards, eco-labeling, management and auditing. Management of packaging waste.

**ATS-602 Technical Textiles** **2+1** **Sem. I**

**Unit I** Introduction to technical textiles

Technical textiles- importance, classification, types of fibres and materials.

**Unit II** Developments in nano fibres and micro fibres

Types of nano and micro fibres, performance characteristics, production and application; Developments in nano fibre based nonwovens.

**Unit III** Technical textiles in industrial applications

Agro tech, Build tech, Geo tech, Mobil tech, Pack tech, Indu tech and Oeko tech.

**Unit IV** Technical textiles in personal environment

Medi tech, Pro tech, Sport tech, Home tech and Cloth tech.

**Unit V** Smart textiles

Factors affecting the selection and uses of smart textiles, phase change materials, chromic materials, shape memory materials. Conductive materials and other functional materials characteristics and its applications.

**Practical** : Introduction to all types of technical textiles – showcasing the fabric samples and their applications. Survey for technical textiles in the market and collection of swatches. Identification of swatches, preparation of technical textile portfolio. Preparation of nano particles for an end-use and their characterization and application on textiles. Assessment of the functional property of nano finish on textiles. Agritech applications- mulch formation for nursery raising (interface with Agricultural college). Medi tech applications – preparation of any anti-microbial finishing solution for application on hospital textiles/ patient monitoring/ similar application. Application of anti-microbial finish on fabric. Assessment of anti-microbial finish on fabric – visit to the lab having microbiology facility. Mini project (group activity)- Designing technical textiles/ smart textiles using phase change materials/ shape memory materials/ dopplers etc. for specific functional performance.

**ATS-603 Technological Developments in Textiles and Apparel** **2+0** **Sem. II**

**Unit I** Recent advances in manufacture of textile and garments

Recent researches in production and manufacture of textile fibres, yarns, fabrics and garments. Chemical processing of natural and synthetic textiles and their conversion into clothing.

**Unit II** Developments in the field of functional textiles

Developments in the field of functional textiles; Use of special techniques in textile processing.

**Unit III** Innovations in garment technology and apparel manufacturing

Innovations in apparel designing; Developments in garment manufacturing technology; Advances in retailing, merchandising; biological and psychological aspects of clothing.

**Unit IV** Research issues

Thrust areas of contemporary research and future projections.

**ATS-604 Colour Application in Textiles** **1+1** **Sem. I**

**Unit I** Colour theory and dye structure

Theory of colour science. Dyeing theories- physical, chemical, fibre complex, solid solution and pigment. Dye structure- size, shape and molecular weight of dye, state of the dye, electrical nature of dye molecule, chemical groups attached to dye and dyeing parameters.

**Unit II** Colour measurement system

Colour measurement systems- Spectrophotometer- features, types and viewing systems; Software and hardware for colour measuring systems; Objective specification of colour tri stimulus values, colour strength, colour difference, shade sorting and various colour spaces; Assessment of whiteness, yellowness and brightness; Assessment of fastness of colour.

**Unit III** Computer colour matching

Computer Colour Matching Theory, Isomeric and metameric colour matching, accuracy of match prediction, measurement of reflectance, benefits; Pass Fail Systems.

**Practical** : Identification of dye classes: primary and confirmatory tests- direct, basic, acid, sulphur, vat, and reactive dyes. Handling colour spectrophotometer- familiarization of commands to use software. Recording reflectance values of coloured samples, recording colour strength.

Assessment of colour fastness and recording the grey scale fastness grades. Colour assessment techniques for assessing dyed fibre, yarn and fabric. Determination of relative dye strength in solution. Creation of data files and reproduce dyed samples with the match prediction. Management and interpretation of data generated. Exposure to Pass / Fail system.

**ATS-605 Functional Clothing** **2+1** **Sem. I**

**Unit I** Introduction to functional clothing and other associated aspects

Clothing as a portable environment. Comfort in clothing - principles of heat transfer in apparels, thermal insulation, clothing systems for thermal protection, breathable textiles.

**Unit II** Clothing design for special groups

Functional Design Process; Clothing design for special groups – expectant and lactating mothers, clothing design to accommodate differently abled. Geriatric clothing; Impact Theory- designing impact-protective clothing

**Unit III** Functional and protective clothing

Requirements and designing of functional and protective clothing – sports, farm, military, industrial workers, fire fighters, mines, space and marine. Fastening systems in clothing.

**Practical** : Survey on selected functional clothing available in the market. Functional designing process- Assessment of functional aspects. Designing clothing for expectant woman, nursing mothers, physically handicapped – disabled hands, disabled legs, wheel chair incumbent. Designing protective clothing for pesticide applicators and analysis, selected industrial workers and analysis, fire fighters and analysis. Designing impact clothing- use of different material and techniques of padding. Designing locale specific sports clothes and analysis. Mini Project- Designing customized functional clothing.

**ATS-606 Textile Conservation** **1+1** **Sem. II**

**Unit I** Introduction to textile conservation

Importance of textile conservation; Important terminologies in conservation; Various methods for analysis of textiles - fibre content, yarn and fabric structure.

**Unit II** Object examination & assessment

Object examination; Damage causing agents – insects, pests, microorganisms, mildew, and environmental factors; Condition assessment, repair and stabilization of textiles and apparel in museum collections; Recording, handling and pre-preparations in conservation; Materials and methods used for conservation treatments.

**Unit III** Support and considerations in textile conservation

Support and Considerations in textile conservation; Reassembly and Finishing; Examination of storage and exhibition techniques; Transportation of artifacts/ historic textiles; Equipment and the workspace for textile conservation

**Unit IV** Principles of cleaning fragile textiles

Principles of cleaning fragile textiles; Dry, aqueous and solvent cleaning; Conservation of Linen and Flags, historic costumes and feather work, lace, leather goods, tapestries and carpets; Proper conditions for storage and display of various textiles.

**Practical** : Visit to a museum and study of various textile conservation methods. Analysis of aged textiles- fibre content, yarn and fabric structure. Assessment of damage. Repair and stabilization of textiles. Determination of colour strength. Exposure to cleaning techniques. Mini Project work.

**ATS-607 Operational Management in Textiles and Apparel** **2+0** **Sem. II**

**Unit I** Scope of production and operations management in textiles and apparel

Scope of production and operations management in textiles and apparel, methods and measurement of capacity planning. Plant climatology - Plant building and its significance, considerations of building design, types of industrial building- plant lighting: need, types and factors governing. Importance of ventilation.

**Unit II** Plant location

Plant location: factors governing, types of location: rural, sub-urban and urban, merits and demerits. Plant layout: objectives of scientific layout, principles of layout, types of material flow, factors governing the layout, types of layouts, merits and demerits

**Unit III** Material handling

Material handling- need, classification, handling costs, principles and types of material handling equipment; Maintenance management- need, types, organisation of maintenance department, maintenance audit, maintenance cost, maintenance indices.

**Unit IV** Work study

Work study- need, objectives from apparel and textile industry point of view; Method study- steps in method study, tools of record. Time study-time and motion economy, steps, elements, allowances, work measurement and derivation for standard minute value (s m v or s a m ) – calculations from apparel industry; Ergonomics- meaning, scope in apparel and textile industry, impact on working conditions and productivity, recommendations for better ergonomically conditions.

**Unit V** Automation in Textile & Apparel Industries & Government Policies

Mechatronics in Apparel & Textile Industries; Scope for Robotics and applications in Apparel & textile Industries; Policies of the government in export and import of materials and made-ups. Government initiatives for various sectors of textile and apparel industry.

**ATS-608 Technology of Non-wovens** **2+0** **Sem. II**

**Unit I** Development of the non-woven industry

Development of the non-woven industry. Types of Non-woven- dry, wet and polymer- laid non-woven, web formation, bonding and raw materials.

**Unit II** Types of web formation

Types of web formation, mixing and blending, card clothing, cross lapping. Developments, physical properties and Practical applications of air laid fabrics. Wet-laid fabrics- raw materials, bonding systems, finishing and product application. Polymer- laid fabrics- raw materials, bonding techniques, spun-bond fabrics, characteristics, properties and other extrusion properties.

**Unit III** Types of bonding

Types of bonding: Mechanical bonding- stitch, needle punching, hydro entanglements process technology and applications. Thermal bonding- raw materials, contact, thermal reaction/ infrared and ultrasonic bonding and applications. Chemical bonding- chemicals, binder polymers, mechanism, drying and applications.

**Unit IV** Non-woven fabric finishing

Non-woven fabric finishing - wet, chemical, lamination, mechanical, surface and other developing technologies. Fabric inspection.

**Unit V** Characterization of non-woven fabrics

Characterization of non-woven fabrics - weight, thickness, density and other structural parameters. General standards for testing non wovens- absorption, strength, bonder and optional properties.

**ATS-609 Special Project** **0+2** **Sem. I**

**ATS-691 Seminar I** **1+0**

**ATS-692 Seminar II** **1+0**

**ATS-699 Ph.D. Research** **0+75**

# FASHION DESIGNING

## B.Sc. (Hons) Fashion Designing - 4 Year Programme

**FD 101 Basics of Design Composition** **1+2** **Sem. I**

Definition of art. Introduction to art media. Elements and principles of design. Dimensions of colour. Colour schemes - their importance and application. Types of motifs and trends in Indian art.

**Practical** : Materials, equipment and techniques of drawing and rendering. Basic sketching techniques. Free hand sketching of various objects and scenes. Composition of floral, geometrical and abstract designs. Colour wheel - grey scales and various colour schemes. Developing colour combinations. Placement of motifs in repeat. Enlargement of motifs. Development of design portfolio.

**FD 102 Visual Studies and Appreciation** **0+2** **Sem. I**

Aesthetics in nature. Situational analysis and inspiration from different elements of nature. Nature drawing-leaves, flowers and trees. Shading techniques for creating different effects. Object drawing with reference to light and angle of sight.

**FD 103 Introductory Textiles** **2+1** **Sem. I**

Basic textile terminology. Classification of textile fibres. Properties and uses of natural and man-made fibres/fabrics. Different types of fabrics - woven, non-woven, knitted and felted. Classification, importance and utility of finishes applied on fabric. Labels and tags used in textiles.

**Practical** : Identification of fibres by non-technical, burning, microscopic and chemical tests. Study of thread count and yarn types, drapability and weight of fabrics. Collection and interpretation of labels and tags used in yarns and fabrics. Survey of common fabrics available in the market. Stain removal.

**FD 104 Introductory Sewing Techniques** **0+3** **Sem. I**

Use of sewing equipment and supplies. Preparation for layout of fabrics - plain, printed, plaid and stripes. Handling specialty fabrics. Use of selected stitches, seams, seam finishes, gathers, pleats, tucks, placket openings and fasteners in infants' garments. Finishing of different necklines and baby collars. Market survey of infants' fabrics and garment designs. Application of different types of fabrics according to the garments. Preparation of infant's layette. Portfolio development.

**FD 105 Dynamics of Fashion** **2+0** **Sem. I**

Fashion terminology. Components of fashion. Movement of fashion - fashion cycle and its stages. Fashion adoption theories. Factors influencing fashion movement. Consumer identification with fashion.

**FD 106 Introduction to Apparel Industry** **2+0** **Sem. I**

Brief history and development of textile and apparel industry. SWOT analysis. Major apparel exporting and importing countries. Introduction and roles of various departments, design, sampling, sales, sourcing, merchandising and production. Future prospects of domestic and global apparel industry. Export oriented units and organizations for export promotion. Incentives given to apparel industry by the government -central and state.

**FD 107 Textile Decorations** **0+3** **Sem. I**

Styles in fabric painting. Textile embellishment with pasementaries. Block, screen and stencil printing. Innovations in printing. Industrial survey of the popularly used printing techniques. Market survey of embellishments and pasementaries used in apparel. Report writing and presentation.

**FD 111 Fashion Drawing-I** **0+2** **Sem. II**

Proportions of human figure - female. Developing female figures using figure guides. Sketching faces, hands, legs, feet, hair styles and accessories. Free-hand sketching of figures. Study of different silhouettes. Study of figure proportions in relation to draped apparel.

**FD 112 Fashion Studies** **2+0 Sem. II**

Effect of different cultures on the development of fashion. Relationship between social, psychological, economic, demographic, life style factors and fashion trends. Exploration of fashion, art, architecture, textiles, costume, customs and rituals in major art and fashion cities of the world.

**FD 113 Pattern Making and Garment Construction-I** **1+2 Sem. II**

Basic terminology. Use of different techniques of garment construction - drafting, pattern making, flat pattern and draping. Different types of patterns. Children's body measurement chart.

**Practical** : Drafting of a child's bodice block and its adaptation. Designing and pattern making of frocks, tops, skirts, shirts and contemporary lower garments. Group assignment on children's line development.

**FD 114 Introduction to Knitwear Technology** **1+2 Sem. II**

Knitting terminology. Types, construction and working of knitting machines. Types of knitting. Different types of knitted fabrics. Qualities of knit structures. Status of knitwear industry in India.

**Practical** : Study of yarns for knitwear. Preparation of samples of tuck stitch, slip stitch and multi-coloured knitting. Preparation of samples of various designs by hand and machine knitting. Preparation of hand/ machine knitted articles. Visit to knitwear industry.

**FD 115 Woven Structures** **1+2 Sem. II**

Parts of a loom. Types of looms and loom operations. Types, characteristics and uses of different simple and novelty weaves. Defects in woven structures. Difference between knitted and woven structures.

**Practical** : Parts of a loom and loom motions. Preparation of drafts of different weaves. Design development on loom. Designing of a woven article. Collection of woven samples and their weave analysis.

**FD 201 Fashion Drawing-II** **0+3 Sem. I**

Proportions of human figure - kids. Developing kids figure using figure guides. Sketching of various garment details - collars, necklines, sleeves, cuffs, gathers, pleats and folds. Flat-sketching of various garments (front and back). Sketching of accessories. Costume anatomy (style lines). Garment draping on fashion figures. Designing garments for various age groups. Techniques of creating textures and patterns. Analysis of design collections of famous designers. Case studies of famous national and international designers. Development of fashion portfolio.

**FD 202 Merchandising Fashion** **2+2 Sem. I**

Careers in merchandising. Fashion merchandising concepts and responsibilities. Trade merchandising systems - international fashion market and domestic market. Policies for fashion distribution. Fashion forecasting and market research. Merchandising fashion in relation to family cycle. Budgeting fashion merchandise - importance and types of financial plans.

**Practical** : Preparation of merchandiser's buying plan. Two week's internship in stores to study the merchandising system.

**FD 203 Traditional Textiles** **2+1 Sem. I**

Traditional textiles of various states of India. Design characteristics of various woven, dyed, printed and painted textiles.

**Practical** : Identification of different types of textiles - contemporary and modern. Collection of traditional motifs and designs used in textiles. Field visit.

**FD 204 Pattern Making and Garment Construction-II** **0+2 Sem. I**

Anthropometric measurements. Adult's body measurement chart. Developing adult bodice block. Different neck lines, yokes, collars and sleeves. Different types of trousers and skirts. Adaptation of bodice, designing and pattern making of various garments - blouse/blouson, corsets, jackets, skirts, trousers etc. Construction of selected garments. Portfolio development.

**FD 205 Knitwear Designing** **0+2** **Sem. I**

Preparation of designed machine knitted samples. Embellishments of knitwears. Study of trends in knitwear. Designing and preparation of machine knitted articles. Portfolio presentation.

**FD 206 Costumes of the World** **2+1** **Sem. I**

Study of historic costumes and accessories of ancient times - Egyptian, Asiatic, Greek, Roman, French and American in relation to fibres, fabrics, colours, motifs and designs used.

**Practical** : Collection of motifs and designs of historic costumes of world. Sketching of four western costumes and accessories. Adaptation of period costumes and designs to five garments of contemporary use.

**FD 207 Computer Aided Fashion Illustrations** **0+2** **Sem. I**

Introduction to the tools. Drawing fashion figures. Designing and draping garments on croqui. Creating effects in various silhouettes. Drafting the basic blocks and fashion details - collars, sleeves, pockets, accessories.

**FD 211 Apparel Production Technology** **1+2** **Sem. II**

Status of apparel industry in India. Structure of apparel industry. Automation in apparel industry. Garment production - sample development and designer's worksheet, pattern making, spreading and cutting, assembling, labeling and finishing. Challenges in apparel industry.

**Practical** : Exercises in development of worksheets and cost sheets for line development of apparel for children/adults. Visit to an apparel manufacturing unit.

**FD 212 Computer Aided Designing and Pattern Making** **0+4** **Sem. II**

Designing various garments using CAD software. Pattern making and marker making of the designed garments for various age groups, using advanced softwares. Introduction to advanced illustration tools.

**FD 213 Draping and Flat Pattern Making** **0+3** **Sem. II**

Terminology and importance of draping and flat pattern making. Tools and equipment used. Preparation of muslin cloth, steps in draping, marking and trueing. Draping basic patterns of bodice block, neck lines, collars, yokes and skirts. Adding and reducing fullness. Construction of selected draped garments - blouse, jacket, skirt, trousers/capris. Development of a sloper. Dart manipulation through flat pattern methods. Portfolio presentation.

**FD 214 Basics of Grading** **0+2** **Sem. II**

General terminology. Importance of grading in readymade garments. Tools and equipment used. Computer aided grading. Types of grades. General principles and techniques of marker making; sloper development; increasing and decreasing patterns of bodice, sleeves, collars, pockets and styled garments. Portfolio presentation.

**FD 215 Indian Costumes** **2+1** **Sem. II**

Study of Indian costumes and accessories of different regions of India from Indus Valley civilization to contemporary times.

**Practical** : Collection of motifs and designs of Indian costumes. Sketching of four Indian costumes and accessories. Adaptation of period costumes and designs to five garments of contemporary use.

**FD 216 Garment Production Machinery and Equipment** **1+1** **Sem. II**

Introduction to industrial sewing machines. Different types of industrial sewing machines - single and double needle machines, button hole and tacker, overlock and interlock machines - their working and function. Care and maintenance of industrial machines.

**Practical** : Hands on training on machines, paper exercises, Machine operations, special attachments and their uses.

**FD 301 Retail Fashion Merchandising and Marketing** **2+1 Sem. I**

Buying terminology. Types of shopping centers. Retail fashion distribution and operations. Retail buying, selling and the fashion cycle. Interpreting customers' demand. Preparation of merchandise plan. Assortment planning and buying. Importance of record keeping. Sales training.

**Practical** : Developing inventories, stock reports and sales reports. Assortment planning for different types of customer profiles and stores. Sales training. Project work and report writing.

**FD 302 Quality Control** **2+2 Sem. I**

Introduction to quality control. Inspection of fabrics, sewing threads, zippers, ancillaries, linings and interlining. In-process inspection. Final inspection. Inspection of labels and packaging. Quality control through physical testing - bow and skewness, shrinkage, colour fastness, strength, crease recovery, drapability, abrasion resistance, light fastness, colour matching. Tests for non-textile accessories. Statistical quality control.

**Practical** : Study of various types of defects - yarn and fabric defects. Pilling and raising defects. Defects related to processing and embellishments. Defects in embroideries. Test for shrinkage, colour fastness, strength, crease recovery, abrasion resistance, pilling, light fastness, colour matching.

**FD 303 Commercial Product Designing** **0+3 Sem. I**

Exercises in design development, style reading, sample preparation, product costing. Drafting, cutting and stitching of garments for different age groups. Project work.

**FD 304 Graphic Design** **0+2 Sem. I**

Concepts of graphics and multimedia. Image manipulation techniques, image correction techniques. Designing brochures, catalogues and newspapers. Designing for publications. Use of different design softwares. Illustrating advertising concepts. Media publishing using in design, motion graphic techniques. 2D animation using macromedia flash. Layout designing, key framing and tweening techniques, introduction to action script programming for interactivity. Approaches to 3D animation. Rendering. Planning and preparing layouts of graphics for designing brochures, flyers, newsletters, stationery, postcards, ads and posters to promote products, product lines, fashion sales and fashion business. Case studies and project.

**FD 305 Dyeing Studies** **1+2 Sem. I**

Classes of dyes. Methods of dyeing. Dyeing machines and industrial dyeing.

**Practical** : Preparation of fabric for dyeing. Dyeing of cotton, wool and silk with different classes of dyes. Resist styles of dyeing. Recent dyeing processes used in industry - a survey.

**FD 306 Textile Printing** **1+2 Sem. I**

Terminology used in printing. Methods of printing different fabrics. Types of printing. Styles of printing - block, screen, stencil, roller and resist printing. Common printing defects, their causes and preventive measures.

**Practical** : Preparation of fabrics for printing. Optimization of printing paste using fixer, binder and colour. Preparation of samples of different styles of printing - block, screen, stencil, roller and resist. Developing products for personal and household use with any one or a combination of different styles of printing. Visit to a printing unit.

**FD 307 Trims and Accessories** **2+0 Sem. I**

Garment accessories - selection and design, functional utility and aesthetic performance. Characteristics of different types of trims and accessories- ribbons, braids, laces, buttons, zippers, snap fasteners, hooks & eyes, hook & loop tape, eyelets. Sourcing of different trims and accessories and preparation of a portfolio.

**FD 311 Fashion Communication** **1+1 Sem. II**

Concept, definition and scope of communication. Functions of mass communication through different media. Role of media in society and its need in fashion world. Media ethics. Creative writing. Interviews-types and how to conduct it. Designing catalogues and brochures. Editing and its various techniques. Event management- fashion shows and photo shoots.

**Practical** : Creative photo shoots, network fashion communication, writing of fashion articles.

**FD 312 Sociological, Psychological and Ethical Aspects of Fashion** **2+0 Sem. II**

Sociological factors influencing fashion - Impact of culture, society, myths and rituals, ethnocentrism and ethnic dresses and contemporary culture on fashion. Historic view of fashion history. Impact of demographic sub culture, age, race, income and social classes. Types of social influences, social comparison, compliance and obedience to norms. Fashion independence - resistance to influence, opinion leadership, buying and disposing of fashion. Psychological factors affecting fashion - group conformity, creativity, sexual attraction, fashion adoption leadership, individuality and brand consciousness. Ethics in fashion and ethical consumerism - Consumer protection, offensive fashion advertising, imitation, stealing of design concepts, adoption of ethical means for fashion brands, workers' rights, chemicals used in production and processing, labour issues, exploitation in fashion industry and other social and environmental effects.

**FD 313 Apparel Supply Chain Management** **2+0 Sem. II**

Introduction to supply chain management - its need and importance. Principles of supply chain development. Hierarchy of supply chain and its components. Critical analysis of nature of supply chain management for products and services. Impact of global economy on supply management process. Integrated supply chain management. Strategies for customer service, quality and inventory management. Factors affecting the supply chain and their effective management. Case studies and critical evaluation of companies' supply chain development and management.

**FD 314 Visual Merchandising** **1+1 Sem. II**

Concept of visual merchandising. Definition, techniques, principles and importance. Theory of colour, form, composition and proportion. Study of store design objectives, techniques and layout.

**Practical** : Project report on existing visual merchandising practices followed by different retail outlets. Presentation on visual illustration and merchandising on selected themes.

**FD 315 Craft Documentation** **2+4 Sem. II**

Use of primary and secondary sources for documentation of selected craft- history, region, motifs, design, equipment, production process and techniques, finishing, marketing, uses and product range of a craft. Evolution of the craft from traditional to contemporary times.

**Practical** : Developing a manual of motifs, design, equipment, production process & techniques and finishing of a selected craft from craft hub. Training in the production of the craft from artisans.

**FD 401 Green Technologies in Apparel Manufacturing** **2+0 Sem. I**

Use of certified organic natural fibers (wool, cotton, linen etc.). Use of highly renewable fibers (bamboo, soy etc.). Use of low impact synthetic or recycled fibers. Use of non toxic or reduced toxicity fiber processes and treatments. Use of low impact or natural dyes. Design and colour choices aimed at longevity rather than planned obsolescence. Reduced energy use throughout the product life cycle. Minimal or environmentally appropriate packaging. Importance of carbon credits in apparel and textile manufacturing. Fashion Industry and the environmental issues- use of chemical dyes, cruelty to animals and humans, concern for environment, certifications etc.

**FD 402 Experiential Learning in Fashion and Lifestyle Products** **0+12 Sem. I**

Orientation to experiential learning. Project report on setting up of a 'Fashion and Lifestyle Products' enterprise. Running and managing a 'Fashion and Lifestyle Products' enterprise - market survey, need assessment, designing, construction & costing of prototype, getting orders, production, packaging and

shipment. Developing a product catalogue. Redressal of problems in running 'Fashion and Lifestyle Products' enterprise.

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|---|---|---|
| **FD 410 Seminar** | **0+2** | **Sem. I** |
| **FD 411 Product Line Development/ Presentation** | **0+6** | **Sem. II** |
| **FD 419 Internship I** | **0+12 (NC)** | **Sem. II** |
| **FD 420 Internship II** | **0+4** | **Sem. II** |

# EXTENSION EDUCATION AND COMMUNICATION MANAGEMENT

## PROGRAMMES

**M.Sc.**

**Ph.D**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of Specialization: | Extension Education and Communication Management |
| Required courses | EECM-503, EECM-504, EECM-505, EECM-511. |
| Supporting courses | Stat.-502, Ext.-504 |
| Minor fields | Food and Nutrition, Resource Management and Consumer Science, Human Development and Family Studies, Journalism, Economics, Sociology, Business Management or any other as approved by the Dean Postgraduate Studies. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency courses for students with elective other than Extension Education& | CommunicationManagement/ Home Science Extension and Communication Management<br>As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

### Ph.D

| | |
|---|---|
| Field of specialization | Extension Education and Communication Management. |
| Required courses | EECM-601, EECM-603 |
| Supporting courses | Stat.-522, Stat.-526 |
| Minor fields | Food and Nutrition, Resource Management and Consumer Science, Human Development and Family Studies, Journalism, Economics, Sociology, Business Management or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**EECM 101 Extension Education and Rural Development 3+0 Sem. I**

Home Science education - meaning, philosophy and historical development. Extension Education- concept, importance, philosophy, principles and objectives. Evolution of extension education- glimpses of pre- and post-independence era. Community – meaning, definition, types of communities, community and science Community development programmes- concept, objectives, organization, activities, achievement and failures. Sociology and rural sociology- meaning, scope and importance. Concepts- structural and functional differences between rural, urban and tribal societies. Rural development- concept, need, meaning, aimand functions of extension education for rural development. *Panchayati Raj* Institutions- concept, structure and functioning. Current rural development programmes/ Organisations- SGSY, MGNREGA, IAY, ICDS, Total Sanitation Schemes/ Campaigns etc., ATMA, DRDA. Role of ICAR, SAUs, KVKs/ DAATTCs and NGOs in rural development.

**EECM 102 Diffusion and Adoption of Homestead Technologies 2+1 Sem. II**

Concept and functions of communication. Types of communication- written, verbal and nonverbal. Forms of communication- interpersonal and intrapersonal communication. Levels of communication-horizontal, upward and downward. Communication process, elements- source, message, channel, receiver and feedback. Techniques of communication. Different channels of communication and their characteristics. Theories & models of communication- Berlo's model and Aristotle model. Barriers of communication. Concept and elements of diffusion process- Innovation, channels of communication, social system and time. Innovation–decision process, types of innovation–decision, consequences of innovations. Homestead technology-concept and its relevance to innovation – decision process. Different homestead technologies with special reference to Home Science. Adoption- meaning, definition and adoption process. Factors affecting adoption and innovation – decision process and constraints. Different terms used in diffusion of innovation and adoption process- rate of adoption, overadoption, innovativeness, dissonance, rejection and discontinuance. Adopter categories- concept and types. Social change: concept, theories, dimensions and factors. Change agents and opinion leader- meaning, definitions, and characteristics. Change proneness – acceptance and resistance to social change.

**Practical:** Collection of homestead technologies. Adoption in localities –observation, visit to different entrepreneurs with adopted home stead technologies for business enterprise. Visit to different successful SHGs. Categories of adopters among SHG's members. Analysis and presentation of reports. Identification of change agents in a localities and presentation of reports.

**EECM 201 Women in Agriculture 2+0 Sem. I**

Agricultural and allied sectors in rural India. Role of women in agricultural and allied sectors. Status of farm women -social, economic and health status of women in agriculture. Women friendly tools and implements. Gender issues, women in agriculture Policy, Programmes (government and non-government) and institutions for women in agriculture. Women empowerment in agriculture, agripreneurship and training to farm women.

**EECM 202 Instructional Technology 1+2 Sem. II**

Instructional technology- concept, definition, principles, classification, characteristics, uses and approaches. Audio visual aids (A V Aids) – concept, definition, classifications, purpose, use, advantages and limitations of various AV aids. Criteria for selection and evaluation of AV aids. Instructional methods and latest innovative techniques (simulation, team teaching, micro teaching, video conferencing etc.) - meaning, classification, purpose, use and limitations. Definition, purpose, use, advantages and limitations of projected, non projected aids, electronic and folk media. Lesson planning and evaluation of teaching.

**Practical:** Planning, preparation, presentation of posters, charts, flash cards, display and other AV aids. Handling of audio-visual equipment. Planning, preparation and delivery of teaching/extension lesson. Evaluation of student – teacher performance based on planned lesson.

**EECM 211 Interpersonal and Organizational Skills** **2+1** **Sem. II**

**(For the students of BSc. (Hons.) Fashion Designing)**

Primary concepts associated with interpersonal and organizational communication. Importance and role of communication in management. Forms of interpersonal communication, forms of organization communication. Factors influencing organizational communication. Formal information system. Informal communication in organization. Communication networks-the grapevine, wandering around etc. Non verbal communication. Use of communication skills. Negotiating for conflict management. Guidelines for negotiation. Negotiation processes-integrative process and distributive process. Managing organizational communication- Overcoming barriers to communication. Trust and confidence building. Assertive communication, relationship styles, emotions and attitudes in communication. Improving communication effectiveness - individual skills and organizational skills. Technology and new communication policies in an organization.

**Practical:** Development of soft skills. Formal and Informal organizational communication. Development of negotiation skills. Assertive communication. Field visit.

**EECM 301 Extension Training Management** **1+2** **Sem. I**

Training - concept, definition, related terms and importance. Principles of extension training. Types of training. Training process - phases and their management. Steps of training process - need assessment, formulation of objectives, content planning, selection of training methods and planning of training schedule, execution and evaluation of training. Adult learning and characteristics of adult learner. Qualities of good trainer - communication, training, motivational, facilitation and problem solving skills. Problems in training. Important training institutions in India

**Practical:** Visit to state level training and vocational training institutes, report writing and presentation. Familiarization with offline and online training modules. Hands-on experience of planning and execution of training programme- need assessment, objective formulation, content planning, preparation of training module, selection of training methods, conducting and evaluation of training by using evaluation tools and techniques. Analysis of HRD programmes of any one training institute. Interaction with the HRD professionals. Presentation of reports.

**EECM 302 Programme Development for Rural Families** **1+2** **Sem. II**

Planning - definition and nature. Extension programme planning-concept, definition, objectives and principles. Relevant terms used in programme planning - situation, aims, objectives, problem, solution, project plan, plan of work, calendar of work, etc. Steps in extension programme planning-situation analysis through PRA techniques, need and environment assessment and rapport building. Leader and leadership- meaning, definition and identification of leader. Role of local leaders, involvement of local bodies/ organizations and extension agencies. Programme implementation and constraints. Monitoring and evaluation of extension programme. Critical analysis of few major development programmes under five-year plans.

**Practical:** Establishing rapport with rural families and identification of leader. Conducting baseline survey of village and household using PRA techniques. Analysis of information. Triangulation of information from conventional and PRA methods. Preparation of detailed plan of work for need based short duration programme. Implementation and evaluation of programme. Report writing and presentation.

**EECM 312 Fashion Photography** **1+2** **Sem. II**

**(For the students of BSc.(Hons.) Fashion Designing)**

Introduction to photography as a technique and art. Light- the source of photography. Principles of composition. Understanding fashion photography and the fashion industry. Fashion styling. Studio lighting. Shooting with models and makeup artists. Image editing and retouching/ manipulation techniques. Portfolio presentation.

**Practical:** Basic principles of photography. Camera and camera types. Main controls on a camera. Film and digital image sensor. Exposure. Depth of field. Lighting. Image editing / image editing software. Preparation of portfolio. HECM 401 Instructional Video Prod

**EECM 401 Seminar** **1+0** **Sem. I**

**EECM 402 Instructional Video Production** **0+9** **Sem. I**

**Practical:** Orientation to photography and photographic equipment. Hands on training with different types of professional cameras, writing captions, editing photo using different software, photo features and presentation. Familiarization with instructional video, writing instructions for instructional video. Familiarization with script, hands-on-experience with script writing. Familiarization with video and audio formats. Preparation of amateur instructional video. Familiarization with video camera and operations. Hands-on-training with video camera. Production of video – pre-production, production and post production. Projection and evaluation.

**EECM 403 Public Relation and Social Marketing** **0+2** **Sem. I**

**Practical:** Public relations - concept, objectives, tools, laws and ethics. Visit to Institution under government sector for analysing the public relations institution. Orientation to different models of PR. Designing PR models. Analysis of the situation to find out the social problemsin a community. Assessment and analysis of the problems. Preparation of report on collected information. Planning for social marketing strategy based on the identified problems. Execution of social marketing programme, planning for publicity campaign, execution of publicity campaign. Evaluation of programme and reporting.

**EECM 404 Web Designing and Multimedia Production** **0+9** **Sem. I**

**Practical:** Familiarization with different types of websites. Hands-on-experience with Adobe Photoshop for designing of website. Hands-on-experience with HTML 4.01, writing for construction of website**.** Hands-on-experience with Dreamweaver for construction of website. Hands-on-experience with flash for animations of website,

Familiarization with cascading sheet styles. Familiarization with web analytics, **Practical** orientation to Multimedia application. Multimedia - types of multimedia production. Handling multimedia-parts, connections and peripherals. Scanning, retrieval, capturing and navigating skills. Planning and production of multimedia package. Integrating various media elements i.e. text, graphics, animation, audio and video into an educational application. Multimedia authoring tools - CD and DVD writing techniques, presentation of the prepared Multimedia kit by using LCD Projector.

**EECM 411 Rural Awareness Work Experience (RAWE)** **0+10** **Sem. II**

**Practical:** Orientation to village institutions. Village profiling. Bench mark survey for need assessment using quantitative and participatory approaches. Developing and implementing various instructional media and resources for capacity building. Planning and executing need based interventions on nutritional health, hygiene, resource management, consumer empowerment and family counselling, purchase, care and maintenance of garments and home textiles. Organizing campaigns to address rural issues. Skill development for entrepreneurship. Mobilizing women to form SHGs. Development of marketing linkages. Documentation of ITK. Organizing exhibition cum Farm Women Fair.

**EECM 412 Internship I -Entrepreneurial Placement/In Plant Training** **0+8** **Sem. II**

**Practical:** Placement of students in TV station/ Radio station/ training centres/ KVKs/Publishing Houses/ Printing Press to get acquaintance with the functioning of media production including familiarity with the working of studio, sync studio, compeering, script writing, story boarding, video shooting, editing and synchronization of sound and video. Experience in designing and integrating interface elements, experience in human resourcedevelopment and desk top publishing.

**EECM 413 Internship II Project Report and Presentation** **0+2** **Sem. II**

**Practical:** Preparation of project proposal for establishing multimedia production unit/ printing unit/ training centre/ video production centre complete with resource mobilization, finances, infrastructure and other facilities. Preparation of report and power point presentation of the same.

## Postgraduate Courses

**EECM-501 Global Extension Systems 3+0 Sem. I**

**Unit I** Orientation to extension systems

Early extension efforts; Indian extension systems - reforms, challenges of extension management in India; Paradigm shift in extension systems; Extension approaches in view of globalization and market liberalization; Privatization of extension services – introduction, scope, advantages, limitations and experiences; Decentralization of extension systems; Revolution in extension systems.

**Unit II** Governance and extension systems

Indian governance and role of extension systems - retrospection on Indian governance; Role of extension system; Ministries - rural development, agriculture, science and technology, human resource development, health, industries, education and women and child development; NGO collaboration; Review of five year plans.

**Unit III** ICAR extension system

History; Extension system; Organisational structure; Policy issues; Existing extension systems and challenges; National and regional institutions - vision, objectives, activities, innovations, programmes; Extension systems in SAUs - organisational structure, personnel, roles, innovations, SWOT analysis.

**Unit IV** Extension management and training organisations and institutions

FAO, IFAD, IFRI, WFO, WHO, Biodiversity international, MANAGE, NIRD, National Institute of Agricultural Marketing (NIAM), NAARM, EEI, SAMETI, FTC.

**Unit V** Comparative analysis of extension system India with USA, UK, Israel, China, Pakistan, Bangladesh, Japan, Italy, South Africa, Island, Indonesia, Philippines and Brazil - history, approaches, organizational structure, methodology, services, problems and research linkages.

**EECM-502 Development Communication 2+1 Sem. II**

**Unit I** Over view of development communication

Hypothetical concepts and theoriesPress theories Normative - authoritarian, libertarian, social responsibility, democratic participant Theory; Sociological - uses & gratification, agenda setting; two-step flow; Psychological; Bullet Theory; Theories of persuasion and advocacy; Critical Theory of frank furt school; Attitude change theories; Political economy Theory; Critical cultural Theory of Birmingham school and framing Theory.

**Unit II** National and international perspectives of development communication

National and international perspectives; Evolution of development communication concept; Government and non-government initiatives; Government and non-government organisations - FAO, UNDP, WHO, UNICEF, CARE and strategies.

**Unit III** Millennium development goals (MDGs) and sustainable development goals (SDGs)

Achievements of MDGs - analytical review and recommendations; SDGs - document, vision and objectives; Targets and strategies for implementation.

**Unit IV** Research perspectives of development communication

Emerging issues; Measurable and variables of development communication; Existing research projects; Research lag and supporting organisations.

**Unit V** Media initiatives for development communication

Conventional and contemporary media technologies; Globalisation and media convergence; Ethical issues and media impact analysis.

**Practical** : Research review on hypothetical concepts and theories of Development communication. Presentation on hypothetical concepts and theories of Development communication. Critical analysis of Sustainable Development goals (SDGs). Report writing and presentation on critical analysis of SDGs. Case study preparation focusing national and international organisation efforts for development

communication. Presentation of national and international organisation efforts. Critical review on ongoing Development Communication research projects in respective SAUs. Presentation on ongoing Development Communication research projects. Interaction with personnel and consumers of development communication projects and group discussion. Interaction with personnel and consumers of development communication projects and group discussion. Selection of contemporary media for development of communication issue, dissemination through existing channels of respective SAUs. Analysis of contemporary media for development of communication issue. Selection of contemporary media for development of communication issue, dissemination through existing channels of respective SAUs. Analysis of contemporary media for development of communication issue. Presentation of media analysis of the issue. End term assessment.

**EECM-503 ICT and New Media** **1+3** **Sem. I**

**Unit I** Information communication technology

Information communication technology - components of ICT, role of ICT in community education; IT enabled services - call centre, helpdesks, data warehouse; Current status of application; Government policy on ICT; Emerging research issues.

**Unit II** Perspective of new media

Definitions, Soft and hardware components, Traditional media transition to new media; Knowledge management and archiving; Networks; Social Media - advantages and limitations.

**Unit III** Multimedia

Multimedia - concept and evolution. Digital Audio - sound design and mixing, digital videography and photography, digital text writing.

**Unit IV** Web and blog designing

Hosting; Introduction of HTML and basic tags and HTML document structure; Cascading stylesheets; Text in CSS and working.

**Practical** : Multimedia and emerging technologies - Introduction to Video-on demand, internet - radioand web television. Introduction to Internet and the browsers. Introduction to Internet access and browsing. Introduction to Internet access and browsing extension related websites, blogs and data bases. Exposure to network. Compose e-mails, send and receive mails. Video on demand- different video formats. Creating a Basic Video Clips with Video Editing software. Adding audio into developed videos. Editing of existing videos and audios.Video on demand-accessing downloads and editing of required video formats. Internet radio- Accessing different radio channels in online websites and browsing. Web Television- Exposure and accessing. Impact of new media on traditional media- listing of various traditional media and new media formats- collection of literature. Group discussion /debateon advantages and disadvantages of traditional media and new media. Writing on specialized area on the web. Writing for general interest web- script writing concepts, principles for web. Writing for online- script writing concepts, principles, styles for online. Writing for net newspapers and editions- script writing concepts, principles, styles for online. Writing for blogs and search engines- script writing concepts, principles, styles for online. Writing for video logs, citizen journalism- script writing concepts, principles, styles for online. Evaluation of e-journals- Exposure to electronic journals, browsing sites, accessing and down loading the journal articles. Evaluation of e-journals. Submission of reports. Unique features of web language-, open source softwaresviz, wordpress, joomla, moodle. Introduction and basics toAdvanced HTML. Introduction of Cascading Style Sheets. Orientation – javascript and HTML scripts. Designing web page- Home page (landing page), hyperlinks with using CSS. Practical exercise on designing a web page by using HTML5 and CSS3. How to create responsive (Mobile friendly) Pages with Using HTML5 and CSS3. Designing web page- Home page, hyperlinks - open source softwares viz, Wordpress. Explanation of WordPress Dashboard and creating blog in Wordpress. Hosting a WordPress Blog online. Creating Google Analytics.Adding Google Analytics into HTML page and Wordpress Pages. Introduction to interactive web media- web animation. Understanding web animation- jquery, dream weaver and Photoshop. Exposure to animated graphics in the web. Introduction to designing interactive elements, sound addition. Introduction to web visual editor, creation and editing. Acquiring a domain and webhosting to host the website/blog. Familiarisation with FTP and Cpanel. Hosting website into Online. Updating/change the contents and images online Website

after Hosting. How to take the backups of the website after hosting a website. Tracking Web Traffic from Analytics. End term assessment

**EECM-504 Technology Transfer and Management** **2+1** **Sem. II**

**Unit I** Introduction to technology transfer

Transfer of Technology - Definition and importance; Models of technology transfer - different models, qualitative technology transfer models, dimensions of technology transfer, features of technology package, routes of technology transfer; FLD, OFT, Minikits.

**Unit II** Technology acquisition

Technology acquisition; Alternatives for acquiring new technologies; Reasons; Management of acquired technology; Measures of scale and mechanisms for acquiring technologies - economy of scale, levels of scale, measurement of scale, factors affecting the choice of scale.

**Unit III** Introduction to technology management

Concept and meaning of technology management; Evolution and growth of technology management.

**Unit IV** Role and significance of technology management

Impact of technology on society; Technology and competition; Key issues in managing technological innovation, Forms of technology - product and process technologies; Technology forecasting - methods and principles; Role of government in technology management.

**Unit V** Technological change

Characteristics of technological change; Classification of technological change; Impact of technological change; Technology life cycle; Technology transformation; Technology policies and policy instruments.

**Unit VI** Technology assessment

Technology choice; Technology assessment and refinement; Technology assessment process; Technology leadership and followership; Writing technology assessment report.

**Unit VII** Invention, innovation and creativity

Meaning and differences; Innovation management; Intellectual property management.

**UNIT VIII** Technology adoption, diffusion, and absorption

Technology adoption diffusion and absorption; Role of technology absorption - benefits, constraints in technology absorption, technology package and technological dependence, Indian experience in technology absorption efforts, issues involved in the management of technology absorption and government initiatives.

**UNIT IX** Development of technology

Development process and steps; Technology development and competition; Managing research & development (R & D); Reforms in technology development.

**UNIT X** Social issues in technology management

Technological change and industrial relations; Implementation of rationalization automation in India.

**Practica**l : Note: Students may be attached to ACRIP on Home Science/ Research project all through the semester for practical experience with either one of the departments, or for a stipulated duration with every department may be left to the discretion of course-in-charge. Students' report may consist the following information. Enlisting of technologies already transferred under five disciplines/ research project. Selection of technologies for observation of change attained and preparation of observation schedule. Field visit and interaction with clientele to collect data. Field visit and interaction with clientele to collect data. Filed visit and interaction with clientele to collect data. Analysis of data and preparation of report. Presentation of report and Group discussion on technology refinement/ sustainability issues. Enlisting and description of technologies transferred by the concerned scientist/s during the semester. Description of transfer of technology model and Design and development of transfer of technology process. Presentation of technology transfer process. Preparation and finalisation of work plan for participation in technology

transfer. Execution of work plan as per time line. Analysis of technology adoption and diffusion stages. Preparation and Presentation of report on technology transfer.

**EECM-505 Dynamic Communication skills** **1+2** **Sem. I**

**Unit I** Need and importance of communication in present context

Types of communication skills - verbal, non-verbal and written communication; Types of corporate and business communication skills - oral presentations, group discussions, facing interviews, e-mail, memos, business letters, blogs, inter office memorandums, report writing; Hard and soft skills; difference between hard and soft skills.

**Unit II** Scientific communication

Meaning; Need and importance; Fora of scientific writing - conference, seminar, symposium, workshop and colloquia; Writing for scientific journals; Thesis writing and writing articles for popular media; Farm journalism and its importance in agriculture and allied sectors; Science communication and formats for scientific writing; Writing for scientific journals and heir ratings; NAAS rating; Impact factor and h-index; Oral and poster presentation; Reading and comprehension of - print and audio video media; General and technical articles.

**Unit III** Introduction to public speaking

Types of speeches - persuasive, informative, and motivational or inspirational speech; Structuring the speech - introduction, body content and conclusion; Effective delivery - voice modulation, appearance during speeches and delivery; Platform performance - posture, gesture, eye contact, emphasis, pause, voice pitch, overcoming fear and anxiety of public speaking; Visuals inpresentation - type of visuals for public speaking, tips for effective use, computer aided visual presentation, body language.

**Unit IV** Importance of listening

Introduction; Listening styles - active & passive and direct & indirect listening, thinking & listening, adjusting listening style to that of speaker, social situations & listening; Listening improvement techniques.

**Practical**: Orientation to NAAS rated Journals related to respective discipline. Enlisting relevant national and international journals. Exercise on writing a review article on given topics. Presentation of the topic. Exercise on writing popular articles for Newspapers, Magazines and farm journals in English. Presentation and group discussion. Exercise on writing popular articles for Newspapers, Magazines and farm journals in vernacular language. Presentation and group discussion. Exercise on writing thesis in UAS format. Presentation and group discussion. Exercise on Numbers, Units, Abbreviations and nomenclature. Presentation and group discussion. Scientific style and use of English in research paper. Presentation and group discussion. Exercise on writing business letters, e mail, blogs, Internet etiquettes. Presentation and group discussion. Exercise on listening skills. Presentation and group discussion. Exercise on presentation skills. Presentation and group discussion. Exercise on writing for radio. Presentation and group discussion. Message preparation for SMS. Practice on modalities of SMS dissemination. Presentation and group discussion. Learning skills of indexing, footnote and bibliographic procedures. Presentation and group discussion. Tips for public speaking. Exercise on public speaking. Organising public speaking- Impromptu, Extemporaneous, Manuscript & Memorized. Evaluation of public speaking. End term assessment

**EECM-506 Participatory Programme Management** **1+2** **Sem. I**

**Unit I** Overview to PPM

Concept; Meaning; Importance; Types of participation in development; Advantages and disadvantages of participation by different stakeholders; Role of government and non profit organizations in promoting participation; Conceptual framework of extension programme planning; Objectives; Principles and process.

**Unit II** Participatory planning

Concept; Importance; Process; Techniques of participatory planning - RRA, PRA, PLA and their application in extension; Approaches of participatory planning - cooperative, democratic, bottom up and down.

**Unit III** Project management techniques

Administration of the Project; Concept of Professional management - stakeholder analysis, force field analysis, SWOT analysis, logical framework analysis, PERT, CPM.

**Unit IV** Monitoring and evaluation

Concept; Meaning and importance of monitoring and evaluation; Components of M&E - physical, financial, staff performance; Technical aspects - output, outcome & impact; Trends in people's participation in M & E; Contribution of right to information Act.

**Practical :** Literature survey and research review on different perspectives of PPM. Presentation of review reports. Observation of PPM techniques in SHGs (female groups). Observation of PPM techniques in SHG village federations. Observation of PPM techniques in SHG mandal/ block level federations. Observation of PPM techniques in SHG district level federations. Observation of PPM techniques in SHGs (male groups). Observation of PPM techniques in watershed management groups. Preparation of case study and presentation. Preparation of case study and presentation. Preparation of case study and presentation. Application of PRA methods – Critical analysis of different methods through research review- Mapping techniques. Application of PRA methods – Critical analysis of different methods through research review- Ranking techniques. Application of PRA methods – Critical analysis of different methods through research review- Transaction techniques. Application of PRA methods – Critical analysis of different methods through research review- Focus group discussion. Application of PRA methods – Critical analysis of different methods through research review- Problem analysis. Application of PRA methods – Critical analysis of different methods through research review- Institutional analysis. Preparation and implementation of home improvement work plans. Preparation and implementation of home improvement work plans. Critical evaluation of work plan. Critical evaluation of work plan. Application of project management techniques- PERT. Presentation of feedback on project management techniques- PERT. Application of project management techniques – CPM. Presentation of feedback on project management techniques – CPM. Application of project management techniques- SWOT. Presentation of feedback on project management techniques- SWOT. Application of project management techniques- Stake holder analysis. Presentation of feedback on project management techniques- stakeholder analysis. Application of project management techniques- Logical frame work analysis. Presentation of feedback on project management techniques- Logocal frame work analysis. End term assessment

**EECM-507 Organizational Development and HRD** **1+1** **Sem. II**

**Unit I** Introduction to organization development

Definition; scope and importance; Relevance of organization development in community science; History of organizational development; Revolution in organizational development; Planned change - theories of planned change, models of planned change; General and specific.

**Unit II** Designing interventions for organisational development

Types; Interpersonal and group process approaches - process consultation, third party evaluation; Organisation process approaches - organization confrontation meeting, intergroup relations interventions, large group interventions; Techno-structural interventions - engineering approach, motivational approach, socio-technical systems approach; Human resource management interventions performance management - goal setting performance appraisal and rewards systems.

**Unit III** Introduction to human resource development

Concept; Relationship between human resource management and human resource development; HRD mechanisms - processes and outcomes; HRD matrix; HRD interventions; Roles and competencies of HRD professionals; Challenges in HRD.

**Unit IV** HRD process

Assessing need for HRD; Designing and developing effective HRD programs; Implementing HRD programs; Evaluating effectiveness of HRD programs; HRD audit; HRD culture and climate; Employee development activities - approaches, leadership development, action learning, assessment and development centres; Intellectual capital and HRD.

**Unit V** HRD Trends

Coaching and mentoring; Career management and development; Employee counselling; Competency mapping (CM); People capability maturity model (PCMM); Balanced score card; Appreciative inquiry; Integrating HRD with technology and Employer branding and other emerging trends.

**Practical :** Visit to an organization to study the models of planned change and preparation. Presentation of report on models of planned change. Research review and presentation of organizational interventions in national context. Research review and presentation of organizational interventions in international context. Collection of data/information and preparation of case studies on organizational interventions in health. Collection of data/information and preparation of case studies on organizational interventions in education. Collection of data/information on organizational interventions in welfare and training organizations and preparation of case studies. Presentation of case studies. Study of existing HRD strategies of respective SAUs/Institutions. Analysis of existing HRD strategies of respective SAUs. Analysis of existing HRD strategies of respective Institutions. Presentation of reports with recommendations. Preparation of CM of the organization and planning for planned change. Preparation of PCM of the organization and planning for planned change. Presentation of reports. End term assessment

**EECM-508 Educational Technology** **2+1** **Sem. I**

**Unit I** Overview of educational technology

Meaning; Concepts and scope of educational technology; Instructional design models, Curriculum design and development; Lesson planning; Concept and methodology; Modularised instruction - fundamentals, process, formulation of objectives, selection of media, field testing and evaluation of module.

**Unit II** Teaching learning process

Meaning and characteristics of teaching and learning; Maxims of teaching - stages, forms and levels of teaching and learning; Motivation - concept, importance and techniques; Teaching styles - expert, formal authority, personal model, facilitator, delegator; Learning Styles - visual, aural, read/write, kinaesthetic (VARK).

**Unit III** Teaching learning strategies

Microteaching; Programmed instruction; Simulation role-play; Team teaching; Experiential learning; Traditional media; ICT Applications in education; Multimedia based teaching and learning.

**Unit IV** Current education

Genesis and trends; Management of formal and non formal education in India; Vocationalization of education; Distance education; Guidance and counselling; Innovative instructional aids – web instruction, e learning, virtual laboratories.

**Unit V** Educational technology for differently able

Visual impaired script - advances in braille; Hearing impaired - advances in Indian sign language; People with special needs - educational programs and government policies.

**Unit VI** Evaluation

Question bank; Introduction to evaluation - need and importance in education appraisal of teacher performance; Development of question bank; Evaluation of instructional effectiveness; Competency based question paper; Reliability and validity of question papers.

**Practical :** Identification of key terms in educational technology and preparation of directory. Critical analysis of UG and PG curriculum of Community Science in relation to course objectives. Research review on planning and implementation of lesson planning. Presentation of research review report. Preparation of lesson plan. Conducting class as per lesson plan and self and peer evaluation. Preparation of inventory for identification of teaching styles and execution. Preparation and presentation of report. Preparation of inventory for identification of learning styles and execution. Preparation and presentation of report. Construction of Objective questions- Multiple choice, fill in the blanks. Construction of competency based question paper- Matching, Technical terms. Construction of subjective questions- Short type. Construction of subjective questions- Essay type. Analysis of questions in terms competency evaluation- knowledge, memory, application, analysis. End term assessment.

**EECM-509 Group Dynamics** **2+0 Sem. II**

**Unit I** Introduction to group and group dynamics

Meaning; Characteristics; Types and functions of groups; Stages and process of group formation; Group norms and structure; Values; Ethics; and Morals.

**Unit II** Understanding group behaviour

Definitions; Theories - social comparison, cognitive dissonance, self presentation, drive, social impact, self attention, social cognition theories; Individual; Interpersonal and human behaviour and dimensions. Theories of group formation

**Unit III** Group dynamics

Cooperation; Competition; Communication; Group pressure; Group cohesiveness; Group leadership; Measurement of group dynamics - tools and techniques; Group break down - causes and solutions; Strengths; Weaknesses and myths; Crowds and the mob mentality; Diversity and difference; Group dynamic skills - training and development.

**Unit IV** Managing group

Team building; Conflict management; Stress management; Active listening and feedback; Achieving cooperative group structure.

**Unit V** Understanding collective action in groups

Collective action meaning; Theories and applications; Incentives for collective action; Research reviews on collective action for sustainable group dynamics.

**EECM-510 Community Development and Outreach** **2+1 Sem. I**

**Unit I** Community development

Definition; Issues and concepts; Historical perspective of community development in India and emerged changes since inception to current era.

**Unit II** Approaches

Approaches - concept and characteristic features gandhian approach, community development approach, sectoral approach, target approach, area approach, minimum need approach, integrated or holistic approach, participatory development approach; Strategies - multipurpose strategy, growth oriented strategy and spatial planning strategy; The modernization Theory; Human development model (components, HDI, ranking, genderrelated development index, HPI).

**Unit III** Key principles of community development

Community participation - definition and scope; Inclusion; Equality; Collective action; Empowerment and community development process; Provision of information; Identificationof felt needs and common issues; Consultation for Shared vision; Mobilisation for action; Reflection and evaluation.

**Unit IV** Community development and governance in India

Community development policy in India; Community development perspectives in five yearplans.

**Unit V** Cross cutting edges of community development

Horizontal edges - education, health, women empowerment, skill development, agriculture and caste occupations; Vertical edges - adults, youth, adolescents, children, pregnant and lactating mothers, physically and mentally challenged.

**Unit VI** Outreach of community development

General orientation to outreach models - precede model, evaluation and indicator metrics; Outreach of urban; Rural and tribal community development programmes; Impact - economic and social perspectives.

**Unit VII** Globalisation impact on community development

Impact on social forms - individualism, enclavism and fatalism, transition between gemeinschaft and gesellschaft, issues of migration and mitigation.

**Practical :** Development of special project to study Community Development programme outreach in selected area and execution. Preparation of project report and presentation. Selection of Community development programme and detailed description of the programme in terms of objectives, targets, inputs, expected outputs and outcome. Visit to programme operating area and interaction with stakeholders- implementing agency, personnel and beneficiaries. Visit to programme operating area and interaction with stakeholders- implementing agency, personnel and beneficiaries. Framing of special project for measurement of outreach – title, objectives, study area, research review and plan of wor. Finalisation of tools and techniques for execution of project. Finalisation of tools and techniques for execution of project. Preparation of tools for execution of project. Field testing and finalization of tools. Execution of work plan. Data analysis and preparation of project report. Data analysis and preparation of project report. Presentation of report. End term assessment.

**EECM-511 Climate Change Management** **1+1** **Sem. II**

**Unit I** Basics of climate and climate change

Introduction to climate and climate change - Definition and meaning; Climate change classification; Method of classification; General concept of environmental Science; Natural and manmade causes of climate change; Affects for climate change; Consequences risks and uncertainty of climate change; Climate system; Major predictions.

**Unit II** Greenhouse gases and global warming

Major greenhouse gases and sources; Global warming effect and causes, Responses to global warming; Different views on greenhouse gases and global warming natural resource management; Solid waste management; Biodiversity; Alternative livelihood security; Drought prone technologies.

**Unit III** Climate change Impacts

Impacts on biodiversity - wetland, forest, agriculture, transportation, coastal area, water resources; Global, National and regional impacts; Vulnerability assessment; Climate modelling.

**Unit IV** Climate change policy

Introduction; Various policies in India; National action plan; Sector specific policies and policies instruments; Environment impact assessment; Environment planning and management; Climate resilient technology.

**Unit V** Climate change communication

Introduction - definition, perspectives and importance; Engaging climate change communication; Audiences; Frames; Values and Norms.

**Unit VI** Visual communication on climate impacts and solutions Theories of visual perception; Classification and selection of visuals.

**Unit VII** Advocacy and communicating global climate action National international advocacy groups and organisations; Strategies and programmes.

**UNIT VIII** Role of stake holders

Media; Scientific Experts; Policymakers; and academic institutions on climate change communication.

**Practical :** Visit to Climate management organization to understand strategies and observe the impacts. Identification of climate management needs at home level and development of suitable technology- Apparel and textiles. Identification of climate management needs at home level and development of suitable technology- Food and Nutrition. Identification of climate management needs at home level and development of suitable technology- General health. Identification of climate management needs at home level and development of suitable technology- domestic appliances and arrangements. Identification of climate management needs and development of suitable technology Children and senior citizens. Identification of climate management needs and development of suitable technology differently able. Preparation of climate communication media – print. Preparation of climate communication media – radio. Preparation of climate communication media – video. Preparation of climate communication media – blog/web writing. Exhibition on climate change management. End term assessment.

**EECM-512 Gender Sensitization for Empowerment** **2+0** **Sem. II**

**Unit I** Overview of gender

Concept; Meaning and related terms; Gender sensitization - concept, meaning and importance of gender sensitization; Gender and empowerment - meaning, definitions and need; Gender issues in home - community and organization.

**Unit II** Gender issues

Gender issues and challenges in development; Understanding gender and subordination of women; Gender as a development tool; Policy approaches for women development; Gender perspectives in development of women - roles, responsibilities, access and control over resources, constraints and opportunities.

**Unit III** Gender tool kit for assessment of gender empowerment

Gender budgeting and gender analysis framework - context, activities, resources and programme action profile; Concept of GDI, GEM, GSI; National and regional indicators.

**Unit IV** Gender issues and development

National policy for empowerment of women since independence; Interventions to enhance women's empowerment at individual; Community and national level; Livelihood implications of ender - health and nutrition, agriculture, violence, governance, education, media and legal issues.

**EECM-513 Special Project- Out sourcing for Media product development** **0+2** **Sem. II**

Placement of students in TV station/ Radio station/ training centres/ Publishing Houses/Printing Press to get acquaintance with the development of various media products.

Experience in designing and integrating interface elements, experience in human resource development and desk top publishing. Preparing students for entrepreneurial skills.

**EECM-591 Seminar** **1+0**

**EECM-599 Master's Research** **0+30**

## Ph.D. courses

**EECM-601 Managerial Skills For Extension Professionals** **2+1** **Sem. II**

**Unit I** Orientation to management

Concept; Process; Functions; Management problems in extension organizations; Managerial skill definition, nature and importance; Skills for effective management of extension activities and organizations.

**Unit II** Theories of management

Scientific Theory; Administrative Theory; Bureaucratic Theory; Human relations Theory; Systems Theory y; X&Y Theory.

**Unit III** Strategic planning

Importance; Steps and techniques; Concept of management by objective (MOB) as applicable to extension organizations; Techniques of transactional analysis for improving interpersonal communication.

**Unit IV** Contemporary professional management trends

Artificial intelligence (AI), Unified talent management (UTM); Self-directed micro learning (SDML); Personalisation; Design thinking; Augmented reality and virtual reality tools (AR&VR).

**Unit V** Creative problem solving techniques

Stress management practices; Total quality management (TQM); Team building and management; Concept of learning organization; Time management practices; Management of information system; Self-management techniques.

**Unit VI** Work motivation

Organizational climate; Resource management - concept and methods; Team building- process and strategies at organizational and village levels; Mobilization and empowerment skills; Concept and strategies in mobilization; Concretisation and empowerment of rural people.

**Practical :** Identification of professional management skills required for extension organization through literature survey. Finalisation of major and specific professional management skills. Preparation of case studies of professional extension management professionals and visual presentation. Preparation of inventories for identification of professional skills. Finalisation and presentation of inventories for identification of professional skills. Execution of inventories- interviews with extension professionals in Government organizations. Execution of inventories- interviews with extension professionals in Government organizations. Execution of inventories- interviews with extension professionals in Non-Government organisations. Execution of inventories- interviews with extension professionals in Non-Government organisations. Compilation and analysis of data. Report writing and presentation of data with special reference input training for professional skills. Hands-on-training for selected professional skills. Hands-on-training for selected professional skills. Hands-on-training for selected professional skills. End term assessment.

**EECM-602 Impact Assessment of Development Programmes** **1+2** **Sem. II**

**Unit I** Orientation to development programme

Development issues and goals; National and International Perspectives - goals, strategies, structure and achievements.

**Unit II** Analysis of contemporary national development programmes

Public Health; Nutrition; Education; Environment; Employment; Income generation; Welfare; Marketing; Human Resource Development - objectives, clients, salient features, inputs, deliverables, outputs and outcomes.

**Unit III** Orientation to impact assessment

Sustainability impact; Social impact; Health impact; Environmental and institutional impact -frame works and element; Log frame analysis.

**Unit IV** Impact identification and prediction

Identification techniques - checklist, matrices, networks, overlays, expert systems, professional judgments; Prediction methods - extrapolative-trend and scenario analysis, analogies; Intuitive forecasting from group consensus (Delphi technique); Normative methods - mathematical models, statistical models, field and laboratory experiment methods, physical models and expert judgment.

**Practical :** Documentation of exiting national and international development programmes and their objectives. Presentation and group discussion on developmental issues of each programme. Research review on development policy of India and developed countries. Presentation of comparative analysis. Preparation and presentation of case study on impact of Public Health programmes. Preparation and presentation of case study on impact of Nutrition programmes. Preparation and presentation of case study on impact of Education programmes. Preparation and presentation of case study on impact of Environment programmes. Preparation and presentation of case study on impact of Employment programmes. Preparation and presentation of case study on impact of Income generation programmes. Preparation and presentation of case study on impact of Welfare programmes. Preparation and presentation of case study on Marketing programmes. Consolidate report writing focusing on inputs, deliverables, outputs and outcome of every programmes and analysis of achievements and gaps. Hands-on-experience on impact assessment – measurement of sustainability impact. Hands-on-experience on impact assessment – measurement of social impact. Hands-on-experience on impact assessment – Health impact. Hands-on-experience on impact assessment – Environment. Hands-on-experience on impact assessment – Long frame analysis. Hands-on-experience on impact assessment – Institutional impact. Hands- on-experience on impact identification techniques- Checklist. Hands-on-experience on impact identification techniques- Matrices. Hands-on-experience on impact identification techniques- Networks. Hands-on-experience on impact identification techniques- Overlays. Hands-on-experience on impact identification

techniques- Expert systems. Hands-on- experience on impact identification and prediction techniques- Professional judgements. Hands-on-experience on impact prediction techniques- Trend and scenario analysis. Hands-on-experience on impact prediction techniques- Delphi technique. Hands-on-experience onimpact prediction techniques- Statistical model. Hands-on-experience on impact predictiontechniques- Field and laboratory experiment methods. Selection and planning for impact analysis development programme. Presentation and group discussion. End term assessment.

**EECM-603 Scaling Techniques For Behaviour Research** **1+2** **Sem. II**

**Unit I** Scaling Techniques

Introduction Definition - scaling techniques and behaviour research; Need and importance; Attitude, Knowledge and Practice measurement techniques and relevance to behaviour research.

**Unit II** Structured techniques

Nominal; Ordinal; Interval; Ratio scales; Self rating scales- graphic rating scale; Itemized rating scales- likert scale, semantic differential scale, stapel's scale, multi-dimensional scaling,Thurston scales, guttman scales/scalogram analysis and the q sort technique.

**Unit III** Non structured techniques

Projective - association, completion, construction, expressive, problems and promises; Word association; Sentence completion; Story completion and pictorial; Advantages and limitations for adoption in behaviour research.

**Unit IV** Knowledge and practice tests

Knowledge - objective multiple choice questions (MCQs); True/False Assertion – reason questions; Multiple response questions (MRQs); Text/Numerical matching ranking questions; Sequencing questions; Field simulation questions; Graphical hotspot questions; and Subjective tests; Practice - worksheets, performance metrics.

**Unit V** Scalability of techniques

Measurement of Reliability and Validity of scales.

**Practical :** Presentation of research review on need and importance of scaling techniques in behavior research. Review and presentation of research articles on different scaling techniques Self rating scales- Graphic Rating Scale. Review and presentation of research articles on different scaling techniques Itemised rating scales Likert Scale. Review and presentation of research articles on different scaling techniques-Semantic Differential Scale. Review and presentationof research articles on different scaling techniques- Stapel's Scale. Review and presentationof research articles on different scaling techniques Multi Dimensional Scale. Review and presentation of research articles on different scaling techniques- Thurston Scale. Review and presentation of research articles on different scaling techniques- Scalogram Analysis. Review and presentation of research articles on different scaling techniques-The Q Sort technique. Review and presentation of research articles on Projective techniques- association and sentence completion. Review and presentation of research articles on Projective techniques-Construction, and expressive. Review and presentation of research articles on Projective techniques- Problems and promises. Review and presentation of research articles on Projective techniques- Word association. Review and presentation of research articles on Projective techniques- Story completion and pictorial. Development of Self rating scales- Graphic Rating Scale. Execution and presentation of results. Development of Self rating scales- Likert Scale. Execution and presentation of results. Development of Self rating scales-Semantic Differential Scale. Execution and presentation of results. Development of Self rating scales- Stapel's Scale. Execution and presentation of results. Development of Self rating scales- Multi Dimensional Scale. Execution and presentation of results. Development of Self rating scales- Thurston Scale. Execution and presentation of results. Development of Self rating scales- Scalogram Analysis. Execution and presentation of results. Development of Self rating scales- Q sort technique. Execution and presentation of results. Hands-on-experience in writing research article on scale development. End term assessment.

**EECM-604 Design and Development of e-Extension Project** **0+3** **Sem. I**

**Practical :** Orientation to e-extension projects- Knowledge projects-mooc. Orientation to e-extension projects -Marketing projects- echoupl. Orientation to e-extension projects- Bulk SMS

(Text and Voice) MMS. Orientation to e-extension projects- Video lessons. Orientation to e-extension projects-Virtual class rooms. Orientation to e-extension projects- Off line and Online Community Radio. Interaction with personnel/professionals for understanding of media tools, hardware requirements of e-Extension projects. Interaction with personnel/ professionals for understanding of media tools software requirements of e-Extension projects. Report writing and presentation. Identification of needs for skill development and proposal for skill training to undertake e-Extension project- application of software, access to hardware etc. Orientation to existing e-Extension projects of respective SAUs. *Hands- on-experience in e- Extension projects of SAUs - content development, management and analytics report. *Hands-on-experience in e- Extension projects of SAUs - content development, management and analytics report. *Hands-on-experience in e- Extension projects of SAUs - content development, management and analytics report. *Hands-on- experience in e- Extension projects of SAUs - content development, management and analytics report. *Hands-on-experience in e- Extension projects of SAUs - content development, management and analytics report. *Hands-on-experience in e- Extension projects of SAUs - content development, management and analytics report. *Hands-on-experience in e- Extension projects of SAUs - content development, management and analytics report.

*Hands-on-experience in e- Extension projects of SAUs - content development, management and analytics report. Report writing and presentation. Selection of multimedia e-Extension project and submission of proposal- knowledge management, product promotion, messagealerting, analytical reports, etc.(Example Digital literacy promotion, Audio/ Video streaming, Social media for product promotion). Presentation of proposal. Content development and time lines for execution of project. Execution of project and measurement of analytics as per time line. Report writing and presentation. Practical examination *Placement in e- Extension projects of SAU/IDEA.

**EECM-605 Sustainable Livelihood Systems** **2+0** **Sem. I**

**Unit I** Orientation to livelihood system

Livelihood perspectives - definition, approaches and frame works; Livelihoods and life support systems; Designing livelihood interventions; Process; Tools and technique.

**Unit II** Sustainable livelihood systems

Definition; Origin; Principles; Livelihoods - agriculture, horticulture, sericulture, forestry, animal husbandry, dairying, fisheries, non-farm activities; Urban livelihoods - linkage with food security, nutritional security, health security, livelihood security; Measuring sustainable livelihood systems.

**Unit III** Critical understanding of livelihood interventions

Intervention of national and international organisations - agriculture based, forest based, non-farm based, market-led based; DFID sustainable livelihoods framework - elements, vulnerability context, policies, institutions and processes, coping and adaptive strategies.

**Unit IV** Sustainable development concepts and challenges

Sustainable development concepts and challenges; Ecological; Social and economic dimensions of sustainable development; Peoples participation and sustainability; Indicators of environmental sustainability; Sustainable livelihoods; Quality of life.

**Unit V** Livelihood analysis tool kit

Operational model - tools, process; Gaps and challenges; Institutional issues; Participatory methods for analysis.

**EECM-606 Extension Research Project Management** **1+2** **Sem. I**

**Unit I** Overview to extension research

Definition; Concepts; Models- linear, advisory, facilitation; Types - advisory services, value chains, supply chains, incubation centres, knowledge management; Market led extension; Demand driven extension; Enterprise extension; Mainstreaming extension.

**Unit II** Areas of extension research policy analysis;

Gender issues; Public and private partnership; Product extension; Process extension; Behaviour change - health security, nutritional security, food security; Impact analysis - technology, training; Funding agencies and project proposal formats.

**Unit III** Research project management practices

Project charter and mission; Project life cycle; Project network diagram; Project progress / performance measures; Project resource loading; Project SOW (statement of work); Project WBS (work breakdown structure) – budgeting, cost benefit analysis, resource management; Risk breakdown structure; SWOT.

**Unit IV** Project management approaches and tools

Approaches - result oriented approach, constructivist approach, reflexive approach; Tools -PERT, CPM, GANNT.

**Practical :** Preparation and presentation of case study on linear model extension project. Preparation and presentation of case study on advisory model extension project. Preparation and presentation of case study on facilitation model extension project. Comparative analysis of different models of extension projects. Preparation and presentation of case study on advisory services. Preparation and presentation of case study on value chains. Preparation and presentation of case study on supply chains. Preparation and presentation of case study on incubation centers. Preparation and presentation of case study on knowledge management. Preparation and presentation of case study on market led extension. Preparation and presentation of case study on demand driven extension. Preparation and presentation of case study on enterprise extension. Preparation and presentation of case study on mainstreaming extension. Comparative analysis different extension projects. Identification of niche areas of extension research in Community Science discipline. Identification of organizations for extension research and presentation of organizational objectives. Critical analysis of formats for research project writing and presentation. Preparation of extension research project. Presentation of extension research project. Revising the project as per suggestions. Presentation of case study on Project Life Cycle. Presentation of case study on Project Network Diagram. Presentation of case study on Performance Measures. Presentation of case study on Project Resource Loading. Presentation of case study on Project SOW (statement of work). Presentation of case study on Project WBS (work breakdown structure). Presentation of case study on cost benefit analysis. Presentation of case study on Risk Breakdown Structure; Visit to existing extension research projects of SAU for observation. Report writing. Presentation of report. End term assessment.

**EECM-607 Media Application and Product Promotion** **2+2** **Sem. I**

**Unit I** Introduction to media applications

Internet media and globalization - concepts and theories; Technology and culture - debates, regulation, gatekeeping and ethics-case studies.

**Unit II** Corporate online promotional strategies

Advertising and marketing; Public communication campaigns and global humanitarianism; Multiplatform journalism; Transnational citizen journalism; Grassroots activism and change.

**Unit III** Media prospects of mass communication

Historical development and economic; Social and aesthetic impact on mass culture; Individual and mass consciousness.

**Unit IV** Audience research Definitions; Principles and features; Scope; BARC (Broad Cast Audience Research Council) India; Data management techniques and tools.

**Unit V** Software access

Advanced new media; Design and edit software; Open and purchase sources; Application regulations; Ethics.

**Unit VI** Product promotion

Search Engine Optimization; Social Media Marketing; E-mail marketing - creation, marketing campaign planning, development and execution; Research.

**Unit VII** Social media platforms

Types; Optimization; Product page creation; Analytics.

**UNIT VIII** Social networking

SNS(Social Networking Sites) in India; Advantages and limitations; Critical analysis of role of SNS in mass communication.

**UNIT IX** Introduction to SEO

Targeting key words; Integrating search keywords; Search engines and directories; Page wise optimization process; Page title tags; META Description tag; META keywords Tag.

**UNIT X** Reports

Variables; Time line; Report access protocol; Documentation.

**Practical :** Identify and suggest the suitable keywords for a product. Adding keywords to website and blogs. Preparing Search Engine Optimization (SEO) friendly content for product website. Demonstration to get website listed among top Search in (SEO). Demonstration on off page and on page in SEO. Identifying best practices for Social Media Marketing, including platform level best practices. Connecting product objectives to appropriate Social Media tactics. Creating strong content to engage target audience with marketing message. Creating events to manage content distribution. Creating Social Media policies that combine business objectives with appropriate use of social media channels and content. Creating Fan Pages in Social media platforms. Hands-on-experience- learning targeting right audience. Hands-on-experience on process of running Facebook ads. Creating engaging post and creating brand for business. Creating channel on YouTube. Updating the profile on YouTube Channel. Understanding the Creator Studio of YouTube. Types of videos and different platforms of video creation. Creating videos- Hands-on-Experience. Creating videos- Hands-on-Experience. Uploading videos on YouTube. Practicing SEO of YouTube. Hands-on-experience on Page title tags. Hands-on-experience on META Description Tag. Hands-on-experience on META Keywords Tag. Promotion of videos. Promotion of product on YouTube. Online orientation to email marketing for product promotion. Hands-on-experience on email marketing for product promotion. Review of analytics of product promotion. Presentation of multimedia practice experience. End term assessment.

**EECM-608 Advocacy and Behavior Change Management** **1+2** **Sem. II**

**Unit I** Advocacy

Meaning; Purpose and types of Advocacy; Tools; Techniques and approaches of advocacy; Elements of an advocacy strategy.

**Unit II** Advocacy planning cycle

Planning advocacy campaigns for different stakeholders relationship between advocacy and development; Programme communication and social mobilization; Social marketing- models and approaches.

**Unit III** Behaviour change communication

Concept; Approaches of BCC - functional approach, information processing approach, consistency approach, behaviour modification approach, health belief model and the BJ Fogg Model of behavior change; Role of learning theories - social cognitive Theory, theories of reasoned action and planned behaviour, trans theoretical model of behavior change.

**Unit IV** Processes of behaviour change

Strategic issues and BCC (Health/ Environment/ Consumption); Analysis of BCC campaigns for social mobilization and policy change; BCC campaigns in core areas for stakeholders.

**Unit V** Evidences of behaviour change

Global programs- evidences of WASH communication, HIV/AIDS communication, obesity communication, diabetic communication, concept of green marketing and cause marketing.

**Practical :** Interaction with Advocacy personnel to comprehend the advocacy approaches working with HIV/AIDS patients. Interaction with Advocacy personnel- working with drug/alcohol addicts. Interaction with Advocacy personnel- Family/ Marriage issues. Interaction with Advocacy personnel- working with mentally challenged children. Preparation and presentation of report. Review of research on BCC approaches- Functional approach. Review of research on BCC approaches- Information processing approach. Review of research on BCC approaches- Consistency approach. Review of research on BCC approaches- Behavior modification approach. Review of research on BCC approaches- Health Belief model. Review of research on BCC approaches-BJ Fogg model of behavior change. Report writing and presentation. Case study on Social marketing in India. Identification of Niche research in BCC. Presentation of researchable issues in BCC. End term assessment.

**EECM-691 Seminar I** **1+0**

**EECM-692 Seminar II** **1+0**

**EECM-699 Ph.D. Research** **0+75**

## Courses offered to Certificate Course on Early Childhood care and Education

**EECM 52 Skills for Effective Communication** **3 (1+2)** **Sem. II**

Reading skills: reading tactics, reading styles; Writing skills: importance, stages of writing-pre writing, during writing and post writing stage, writing styles, principles of writing, effective writing, writing reports; Listening skills: importance, listening process, principles, techniques for effective listening, poor listener v/s effective listener; Speaking skills: need and importance, features of speaking, Effective speaking.

**Practical:** Learning experiences in developing reading, listening, speaking and writing skills, Reading comprehension, exercises for active listening and comprehension, exercises on effective speaking, writing resume, press release, memos, business/formal/informal letters, blogs, inter office memorandums, report writing.

**EECM 54 Empowerment through Life skills** **3 (1+2)** **Sem. I**

Soft skills: meaning and significance, Different types of soft skills, Assertive skills, Interpersonal Skills, Emotional Intelligence, Cultural Intelligence, Personality Development, Time Management, Stress Management, Team Building, Leadership Skills, Creative Thinking, Problem Solving Skills, Networking Skills.

**Practical:** Learning experiences in using soft/ life skills in different situations, role plays and simulation games, email/telephone Etiquettes, practical on development of Team Building skills, Leadership Skills, Creative Thinking and Problem Solving Skills.

## Courses offered to Certificate Course on Interior design and decoration

**EECM 51 Fundamentals of Communication** **3 (2+1)** **Sem. I**

Concept of Communication, Origin, Meaning, Definition, Functions, Types, levels, Forms, communication process, models/theories, Approaches, Communicator and Communicatee relationships-empathy, fidelity, credibility, homophily- heterophily, Feedback and Barriers in communication, Communication efficiency and effectiveness, Message Distortion- factors of communication distortion, systematic or stretch distortion, fog distortion and mirage distortion.

**Practical:** Simulations and games on effective communication and message distortion, Exercises on communication barrier, Learning experiences in measuring effectiveness/efficiency of different communication performances in formal and field situations.

# FOOD AND NUTRITION

## PROGRAMMES

**B.Sc. (Hons) Nutrition and Dietetics/ Food Nutrition and Dietetics**

**M.Sc.**

**Ph.D.**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of specialization | Dietetics, Community Nutrition |
| Required courses | FN-501, FN-502, FN-503, FN-504 |
| Supporting courses | Stat.-502, Ext.-504 or other courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Minor field | Food Science and Technology, Biochemistry, Microbiology, Extension Education and Communication Management or any other as approved by the Dean, Postgraduate Studies. |
| Common Courses: | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |

### Ph.D

| | |
|---|---|
| Deficiency courses for students with elective other than Food and Nutrition | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |
| Field of specialization | Dietetics, Community Nutrition |
| Required courses | FN-601, FN-602, FN-603 |
| Supporting courses | A student can opt any course related to the topic of research offered by other faculties of Agriculture University or SWAYAM portal or online courses up to a maximum of 5 credits |
| Minor field | Food Science and Technology, Biochemistry, Microbiology, Extension Education and Communication Management or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**FN 101/ N Diet101 / FND 101 Principles of Human Nutrition 3+0 Sem. I**

Introduction and overview of basic principles of nutrition. Relationship of nutrition to health, growth and human welfare. Definitions of terms used in nutrition- Recommended dietary allowances, balanced diet, health, functional foods, phytochemicals, nutraceuticals, dietary supplements, food groups. Energy-units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of body, physical activity and thermogenic effect of food. BMR- methods of measurement, factors affecting BMR. Digestion and absorption of carbohydrates, lipids and proteins. Carbohydrates-Types, functions, sources, requirement, health conditions affected by carbohydrates, significance of dietary fibre. Lipids- Types, functions, sources, requirement, health problems associated with lipids. Proteins-Types, functions, sources, requirement, quality evaluation, improvement and deficiency and protein energy malnutrition. Vitamins- Classification, functions, sources, requirement, deficiency and toxicity of fat soluble (A, D, E, K), (water soluble – C, B Complex (thiamine, riboflavin, niacin, B6, Pantothenic acid, B12 and folic acid). Minerals- Classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc, bio availability and factors calcium and iron. Water-functions, sources, distribution in body water balance and electrolyte balance.

**FN 102 Fundamentals of Food Science and Processing 2+1 Sem. II**

Food groups, Food guide pyramid and its importance. Foods as a source of nutrients. Objectives of cooking, processing and preservation. Methods of cooking and their merits and demerits. Effect of processing on nutritive value of foods. Functional properties, nutritive value, processing and storage of cereals and millets, pulses, fruits and vegetables, milk and milk products, meat, fish and poultry, nuts & oil seeds, oils and sugars. Types and uses of spices and herbs. Beverages and appetizers- classification and uses with special reference to tea, coffee, cocoa and alcoholic drinks. Classification and functions of leavening agents. Convenience foods : types and uses.

**Practical:** Laboratory conduct and responsibilities. Knowledge of different food stuffs in English, Hindi and local language. Terms used in cookery, weights and measures, identification and use of different kitchen items and equipment. Identification and listing of various food groups, market survey of processed and preserved foods. Preparation of dishes and beverages using cereals, pulses, fruits, vegetables, milk and milk products, egg, fish and meat. Use of leftover foods. Sugar cookery. Preparation of fudge and fondant. Process of caramelization; demonstration of 1-thread and 2-thread consistency. Fats and oils. Preparation of puris, cakes and biscuits. Appetizers. Preparation of hot and cold/season specific beverages. Visit of food processing industries.

**FN 201 Normal and Therapeutic Nutrition 2+1 Sem. I**

Importance of meal planning and factors effecting meal planning . Determination of nutritional requirements- Recommended Dietary Allowances (RDA), calorie consumption unit and food exchange lists Maternal nutrition- physiological changes and nutritionalrequirements during pregnancy and lactation. Infancy- growth, development and nutritional requirements, importance of breast feeding, weaning and supplementary foods. Growth and development, food habits and nutritional requirements of pre-schoolers, school age childrenand adolescents. Geriatric nutrition physiological and psychological changes during old age, nutritional requirements and consideration for diet planning. Importance and modification of normal diet to therapeutic diets. Methods of feeding. Aetiology, symptoms and dietary management of acute and chronic diseases. Fevers- typhoid, tuberculosis, influenza dengue, chickengunia. Gastrointestinal disorders- diarrhoea, constipation and peptic ulcer. Liver diseases- hepatitis, jaundice, cirrhosis. Cardiovascular diseases- atherosclerosis, hypertension and diabetes mellitus. Dietary management in underweight, overweight and obesity.

**Practical:** Standardization of serving size portions. Planning and preparation of diets for different age groups-infancy, pre-schoolers, school age, adolescents, adults and elderly. Planning and preparation of diets for pregnant and lactating women. Planning and preparation of diets for diseased conditions- fevers, diarrhoea, constipation, hepatitis, hypertension, diabetes mellitus, underweight, overweight and obesity.

**FN 202 Food & Nutrition Policy and Agriculture** **2+0 Sem. I**

Food situation in India and world. Food production and consumption trends. Food balance sheets. Role of nutrition in agricultural planning and national development. Linkages between agricultural practices, food production, food distribution and nutritional status. Food crop failure and malnutrition, poverty and vicious cycle of low food production. Effect of agricultural development, food production and economic policies on food availability. Impact of physical resources, farming and cropping systems, inputs and manipulations, agricultural marketing systems and post harvest processing on food and nutrition situation. Food distribution systems. Food security – concept and definition, its relation with agriculture, urbanization, nutrition and health. Food systems and macroeconomic policies- employment and cash income, markets and food prices. Effect of urban agriculture on the nutritional status of vulnerable groups. Innovative approaches to enhance local food production and to improve food distribution systems. Innovative and effective approaches to manage health risks of urban agriculture. Food and nutrition security at national and household level. National Nutrition Policy (NNP) and implementation. Nutritional impact of agricultural programmes, food price control and consumer subsidy. Contribution of national and international organizations for agricultural development.

**FN 203 Community Nutrition and Education** **2+1 Sem. II**

Concepts of community, health, malnutrition, maternal and infant mortality, morbidity and nutritional status. Malnutrition- definition, types, causes and vicious cycle of malnutrition. Assessment of nutritional status using dietary survey, anthropometry, biophysical tests clinical symptoms and biochemical methods. Major nutritional problems and life style diseases prevalent in India - protein energy malnutrition, anaemia, vitamin A deficiency, iodine deficiency disorders, obesity, hypertension, atherosclerosis and diabetes mellitus. National programmes and international agencies in improving nutritional status of the community - Integrated Child Development Service (ICDS), Supplementary Nutrition Program (SNP), Applied Nutrition Program (ANP), Mid Day Meal Program (MDMP), Vitamin A Prophylaxis Program, Anaemia Prophylaxis Programme, Food and Agricultural Organization (FAO), World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF), United Nations Development Programme (UNDP), Cooperative for American Relief Everywhere (CARE). Nutrition education- objectives, methods and principles. Nutrition surveillance.

**Practical:** Assessment of nutritional status of an individual/community using anthropometry and dietary survey **-** preparation of schedule, data collection, analysis of data and report writing. Visit to local health centre to identify clinical signs and symptoms of nutritional problems. Visit to an ICDS Block. Development of audio visual aids- radio script, popular articles, charts/posters, leaflets, folders and models. Planning, implementation and evaluation of nutrition education programme for a target group.

**FN 204 Clinical Nutrition and Dietetics** **2+1 Sem. II**

Clinical Nutrition - Introduction , nutritional status and disease . Pathogenesis of nutritional deficiency diseases. Macronutrient and micronutrient deficiency diseases- protein calorie malnutrition, vitamin A deficiency, anemia, iodine deficiency disorders. Aetiology, risk factors and dietary management of diseases of gastro intestinal tract and liver , chronic obstructive pulmonary disease, diabetes mellitus, cardio vascular and renal diseases. Cancer- causes of cancer cell development, impact of tumor on host metabolism and systemic effects of cancer. Burns - physical destruction of skin, metabolic aberrations and alteration in nutritional requirement. Dietary management of cancer and burns. Interaction between nutrients, infection and drugs.

**Practical:** Nutritional care and documentation of hospitalized patients. Assessment of clinical symptoms during nutritional deficiency disorders - protein energy malnutrition, iron deficiency anaemia, iodine deficiency disorders, fluorosis, vitamin A and vitamin B complex deficiencies. Biochemical assessment of blood and urine and their interpretation in terms of health and diseases. Nutritional intervention during different diseases.

**FN 205 Fundamentals of Food and Nutrition** **1+1** **Sem. II**

Food groups, Food guide pyramid and its importance. Objectives of cooking, processing and preservation. Methods of cooking and their merits and demerits. Relationship of nutrition to health. Energy, definition, determination of energy requirements, food energy, total energy needs of the body. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, assessment of nutritional status of the population.

**Practical:** Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Preparation of dishes and beverages using fruits and vegetables and to estimate their nutritional composition.

**FN 301 Fundamentals of Food Hygiene and Sanitation** **1+1** **Sem. I**

Concept, significance and interrelationship of health, food hygiene and sanitation. Characteristics and factors of good health. Inculcating hygienic habits to promote health. Water- requirement , use, sources, pollution and purification. Potable water- quality, criteria and standards. Hardness of water and its treatment. Defluoridation of water. Food hygiene . Contamination of foods from various sources. Health hazards of plant foods, animals, sewage, soil, air and water. Food spoilage- perishable, semi perishable and non perishable foods. Sanitary procedures for preparation, handling and storage of foods. Causes, symptoms and control of food borne diseases - diarrhoea, dysentery and cholera. Microbial food poisoning - sources, incubation period and mechanism of action. Food poisoning caused by agents other than microorganism - poisonous plants, animals, chemicals, metals and pesticides. Investigation of food poisoning, prevention and control.

**Practical:** Survey of hygienic and sanitary conditions in canteens/cafeterias/food shops/ food vendors. Report writing. Preparation of oral rehydration solution (ORS). Chlorination of water, water testing and purification. Visit to primary health centre and civil hospital. Organization of health and hygiene camps

**FN 302 Home Scale Food Preservation** **1+1** **Sem. I**

Food preservation- introduction and scope. Classification of foods on the basis of shelf life. Food spoilage -causes and effects. Principles and methods of food preservation - drying anddehydration, use of high and low temperature, foods as preservatives, use of chemicals, radiation and combination of above methods. Storage of common perishable, semi- perishable and non-perishable foods. Selection and purchase of foods for preservation. Food standards and quality control. Packaging and packing materials, labelling and costing of products. Food additives, preservatives, anti-oxidants, colouring matter and emulsifying agents.

**Practical:** Preparation and storage of pickles with and without oil, chutneys and sauces. Preparation of squashes, syrups jams, jellies, preserves, marmalades and sugar candies. Demonstration of canning and bottling of fruits and vegetables. Preparation of *papad, wadian* utilizing cereals and legumes and their storage. Drying of blanched and unblanched fruits and vegetables by solar dryer, sun and oven drying methods. Domestic preservation of foods by freezing. Availability of preserved foods in the market.

**FN 303 Food Standards and Quality Control** **2+1** **Sem. II**

Importance of quality control and assurance. Food laws and regulations. Prevention of Food Adulteration Act, Fruit Product Order, AGMARK, Essential Commodities Act, Consumer Protection Act, Food Safety and Standards Act (FSSA), Bureau of Indian Standards and Codex Standards. Specifications and application of food standards for raw material and food additives- preservatives, colorants, antioxidants, emulsifiers, leaveners and stabilizing agents. Methods for quality assessment of different foods. Selection of sensory panel and sensory evaluation of food products. Concept of food adulteration, common adulterants, related health hazards, prevention and control. Food safety, risks and hazard assessment. Food packaging and packaging materials.

**Practical:** Examination of agricultural, horticultural and animal foods and food products in relation to different standards. Development of score cards and sensory evaluation of selected finished products.

Detection of adulterants and preservatives in food products. Visit to quality control laboratory and food processing industries. Market survey of processed foods for quality assurance.

**FN 304 Food Analysis** **2+1** **Sem. II**

Sampling and sampling techniques. Proximate analysis- moisture, ash, crude fat, crude fibre, crude protein and carbohydrates. Principles and methods of food analysis. Basic principles of different analytical techniques - refractometry, polarimetry, densitometry, High Performance Liquid Chromatography(HPLC), Gas Liquid Chromatography(GLC), spectrophotometry, electrophoresis, automatic amino acid analyzer. Determination of starch. Test for unsaturation of fats and rancidity of fats. Quantitative analysis of protein by Biuret method, Ninhydrin method, Lowry's method and Dye-binding method. Bioassays for protein quality of grains. Chemical, microbiological, fluorometric and colorimetric methods of analysis of fat soluble and water soluble vitamins. Principles and methods for estimation of minerals- atomic absorption spectroscopy, colorimetric, titrimetric and gravimetric. Methods for determining physical and rheological properties of food.

**Practical**: Proximate analysis- moisture, ash, crude fat, crude fibre, crude protein and carbohydrate. Demonstration of kelplus, fibraplus, socsplus for estimation of protein, fibre and fat. Estimation of reducing and non-reducing sugars in fruits. Estimation of starch content of cereals. Determination of iodine value and saponification number of fats. Physical tests for grain quality and rheological properties of foods.

**FN 305 Bakery and Confectionary** **0+2** **Sem. II**

**Practical:** Terms and techniques used in bakery. Use of different bakery equipment. Selection, properties and functions of various ingredients - flour, fat, sugar, eggs, salt, milk, yeast, baking powder used in bakery and confectionery. Role of gluten and starch in bakery products. Rheological properties of doughs and batters. Emulsifiers used in bakery. Balancing the formula for bakery products. Demonstration on standard method of making different types of biscuits- sweet, salty, coconut and fruit biscuits. Demonstration on standard method of making different types of cookies - peanuts, cornflakes, and choco chips, coconut macrons. Demonstration on standard method of making different types of cakes- plain cake, sponge cake, chocolate cake, pineapple upside down cake, walnut cake, fruit / plum cake and carrot cake. Demonstration on standard method of making of pastries. Icings and cake decoration. Preparation of supplemented and therapeutic baked products- cakes, biscuits, cookies, bread and desserts.

**FN 306 Food Science and Human Nutrition** **1+1** **Sem. II**

Concepts of Food Science (definition, measurements, density, phase change, pH, osmosis, surfacetension, colloidal systems, etc); Foodcompositionand Chemistry(water, carbohydrates, proteins, fats, vitamins, minerals, flavors, colours miscellaneous, Bioactives and important reactions); Functions and sources of carbohydrates, proteins, fats, vitamins, minerals and water; Food microbiology (bacteria, yeast, moulds, spoilage of fresh and processed foods, Production of fermented foods); Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying, etc); Relationship between food, nutrition, agriculture and malnutrition (over and under nutrition); nutritional deficiencies (PEM, IDA, IDD, VAD and fluorosis) and nutritional disorders (diabetes mellitus and CVD); Energy metabolism (carbohydrates, fat and proteins); RDA; Balanced/modified diets; Menu planning; New trends in Food Science and Nutrition (nutraceuticals, antioxidants, nanotechnology and functional foods).

**Practical:** Market survey to collect information about cost of different foods in five food groups, availability of food supplements and processed foods. Survey of households to know food habits of families. Learning to plan recipes rich in energy, protein and micronutrients. Planning balanced diets for adults and different income groups.

**FN 401 Seminar** **1+0** **Sem. I**

**FN 402 Experiential Learning-I Bakery and Confectionary** **0+8** **Sem. I**

**Practical:** Introduction to bakery unit. Equipment used in bakery unit. Maintenance of hygiene and sanitation. Preparation and maintenance of work area, work place ethics. Role and responsibility of baker Terms and techniques used in the bakery. Overview of bakery ingredients. Selection and purchase of

material for the preparation of bakery products. Faults and remedies of bakery products. quality check of baked products. Balancing of formula for preparation of baked products. Demonstration and preparation of cakes, breads and muffins. Demonstration and preparation of biscuits and cookies. Standardization for portion and costing of various products. Production plan- organization of resources, sequential grouping of activities and time management. Packaging, post-production cleaning and documentation and record keeping.

**FN 403 Experiential Learning-II Bakery and Confectionary 0+12 Sem. I**

**Practical:** Preparation and marketing of different kinds of cakes. Preparation and marketing of different kinds of biscuits and cookies. Preparation and marketing of different kinds of breads. Preparation and marketing of different kinds of fermented bakery products- doughnuts, pizza etc. Preparation and marketing of different kinds of puddings. Preparation and marketing of different kinds of chocolates. Preparation and marketing of innovative value added bakery products. Preparation and marketing of different kinds of muffins. Preparation and marketing of decorative cakes. Visit to different bakery units. Assessment of sale performance- profit generated. Preparation of project proposal. Presentation of project proposal and evaluation.

**FN 412 Internship-I Entrepreneurial Placement/Inplant Training 0+8 Sem. II**

**Practical** : Acquaintance with the working of dietary departments in the hospitals. To record the clinical, nutritional and biochemical profile of the patients and modification of diets accordingly. Prescription of therapeutic diets. Organization, management and administration in institutions such as canteen/ cafeteria, nursery school/ day care centre/ hostel mess for one week. Visit to different food service institutions. Training in food service institutions.

**FN 413 Internship-II Project Report and Presentation 0+2 Sem. II**

**Practical** : Development of entrepreneurial and managerial skills. Preparation of project proposal for establishing diet counselling cell including resource mobilisation, finance, raw material, site and manpower. Report writing and presentation.

## Postgraduate Courses

## M.Sc. Courses

**FN-501 Macro and Micro Nutrients in Human Nutrition 3+0 Sem. I**

**Unit I** Carbohydrates

Body composition; Functions, sources, requirements, digestion and absorption of carbohydrates. Composition, classification and functions of dietary fibre; Role of dietary fibre, resistant starch and fructo-oligosaccharides in various physiological disorders; Glycemic response to carbohydrates.

**Unit I**I Proteins

Classification, functions, sources, digestion and absorption of proteins; Synthesis of non- essential amino acids in the body; Urea cycle; Protein quality; Relationship between energy and protein requirements; Regulation of food intake; Nutrient adaptation to low intake of energy and protein.

**Unit III** Fats

Classification, functions, sources, digestion, absorption and deficiency disorders of lipids and essential fatty acids; Role of omega-3 and omega 6 fatty acids in physiological disorders.

**Unit IV** Vitamins, minerals and water

Functions, absorption, requirement, sources, deficiency and toxicity of fat-soluble vitamins - A, D, E and K and water-soluble vitamins- thiamine, riboflavin, niacin, pyridoxine, folate, B12, ascorbic acid, pantothenic acid, biotin and amygdalin; Functions, absorption, requirement, sources, deficiency and toxicity of macro minerals – calcium and phosphorus and micro minerals – iron, zinc, sodium, copper, cobalt, selenium and chromium; Water and electrolyte balance, functions and distribution of water in body, Electrolyte composition of body fluids and electrolyte balance.

**FN-502 Public Health and Nutrition** **2+1** **Sem. I**

**Unit I** Nutritional status assessment

Assessment of nutritional status at individual, household and institutional level: direct and indirect methods; Ecological, socio-cultural, economic and demographic correlations of malnutrition.

**Unit II** Nutritional deficiencies and life style disorders

Prevalence, aetiology, biochemical and metabolic changes in protein energy malnutrition, vitamin A deficiency, iron deficiency anaemia, iodine deficiency disorders, diabetes mellitus, cancer, hypertension and other life style disorders.

**Unit III** Present scenario of nutritional problems

Major nutritional problems of the state, nation and world; Nutrition intervention- definition, importance, methods of nutrition intervention, monitoring and evaluation; E-surveillance.

**Unit IV** Nutritional programmes and polices

National nutritional programmes and policies and nutritional surveillance; National programmes and policies regarding food production and distribution.

**Practical :** Techniques of assessment of nutritional status. Use of Screening Tools. Visit to the ongoing public health nutrition programme and report writing. Study of existing diet and nutrition practices. Planning and conducting survey. Analysing data and writing report. Development, implementation and evaluation of community nutrition and health programmes.

**FN-503 Techniques in Food Analysis** **1+2** **Sem. II**

**Unit I** Sampling techniques

Preparation of various standard solutions; Sample and sampling techniques; Introduction to standard analytical methods of FSSAI.

**Unit II** Analytical techniques

Principle, techniques and applications of colorimeter, spectrophotometer and atomic absorption spectrophotometer, gel filtration and ultra-centrifugation.

**Unit III** Photometric methods and electrophoresis

Principle, techniques and applications of fluorimetry, flame photometry and electrophoresis.

**Unit IV** Chromatography

Principle, techniques and applications of paper, thin layer, gas liquid and high-pressure liquid chromatography, introduction to animal assay.

**Practical** : Principles and operation of laboratory equipment. Determination of moisture content and titratable acidity. Determination of ash- dry and wet ash. Determination of reducing sugars and total sugars. Analysis of protein- Kjeldhal method. Analysis of amino acids- HPLC. Analysis of fat - Soxhlet method, Cold extraction method. Determination of peroxide value and iodine value. Analysis of crude fibre. Analysis of minerals- sodium and potassium. Analysis of iron, copper, zinc and lead. Absorption spectrophotometry. Analysis of phosphorus- Colorimeter method. Analysis of vitamin C. Estimation of carotene. Experiments on gel electrophoresis.

**FN-504 Diet Therapy** **2+1** **Sem. II**

**Unit I** Significance of diet therapy

Importance and scope of diet therapy; Role of dietician in a health care team in hospital and community.

**Unit II** Dietary management of nutritional disorders

Newer concepts in dietary management of various nutritional disorders and disease conditions; fevers and infections.

**Unit III** Dietary management of diseases

Dietary management during burns, allergy, gastrointestinal disorders, liver diseases, cardiovascular diseases, hypertension, renal disorders, obesity, diabetes, cancer and HIV; Nutrition in critical care.

**Unit IV** Nutrigenomics and nutraceuticals

Nutrigenomics. Nutraceuticals. Health foods and supplements; Health foods and supplements; Dietary recommendations for blood donors; Nutrients and drug interaction.

**Practical** : Formulation of food exchanges. Therapeutic modifications of diet in terms of nutrients, consistency and composition. Planning and preparation of diet for diabetes. Planning and preparation of diet for cardiovascular diseases. Planning and preparation of diet for kidney disorders Planning and preparation of diet for obesity. Planning and preparation of diet for cancer patients. Planning and preparation of diet for burns patients -first, second and third degree burns. Planning and preparation of diet for gastrointestinal disorders. Planning of diet for critical care patients. Visits to hospital to see preparation of tube feeding diets. Presentation of case studies.

**FN-505 Nutrition and Physical Fitness** **2+1** **Sem. I**

**Unit I** Physical fitness and body composition

Overview of nutritional management vis-à-vis body composition and physical fitness; Techniques to assess physical fitness; Body composition in different physiological conditions and factors affecting it; Methods of measuring body composition.

**Unit II** Energy balance

Energy metabolism; Factors influencing energy metabolism and physical fitness; Techniques to measure energy expenditure and energy intake.

**Unit III** Sports nutrition

Requirement of nutrients for specific sports events; Exercise physiology and biochemistry; Nutrition support before, during and after sports event; Water and electrolyte requirement during exercise and their role in performance; Ergogenic aids: Definition, types and dosage; Doping: Definition, types and consequences; Muscle physiology for performance and fitness; Biomechanics; Physiological testing for fitness and performance; Strength, flexibility, anaerobic power and cardio respiratory fitness.

**Unit IV** Nutrition and ageing

Role of nutraceuticals in fitness; Aging theories; Physiology, mechanism and role of nutrients in arresting aging process.

**Practical :** Planning diets for general fitness. Planning and preparation of diets for different sports categories. Planning nutritional requirements for sports injuries. Visit to a sports academy. Visit to established fitness centres.

**FN-506 Developments in Nutrition and Immunity** **2+0** **Sem. II**

**Unit I** Immunity and macronutrients

Immunity: definition and history; Classification of immunity and immunological responses; Role of nutrients in immune functions- Carbohydrates, fat and protein; Effect of arginine, glutamine, sulphur amino acids and omega-3 fatty acids on immune system.

**Unit I**I Immunity and micronutrients

Effect of deficiency and excess of vitamins and minerals on immune cell functions; Effect of malnutrition on immunity; Infections and undernutrition – causes and consequences and role of immunization.

**Unit I**II Nutrition during infections

Age related immune depression; Role of nutraceuticals and functional foods in immune system; Nutrition, HIV/AIDS and Tuberculosis.

**Unit IV** Immunity and chronic diseases

Nutritional immunity and chronic diseases; Probiotics, prebiotics, phytochemicals and immunity; Food allergy.

**FN-507 Clinical Nutrition** **2+1** **Sem. II**

**Unit I** Macronutrients

Methods for estimating requirements and recommended allowances of energy, protein, minerals and vitamins for different age groups and physiological state; Growth studies; Depletion and repletion studies; Nutrient balance studies; Use of isotopically labelled nutrients: Nutrient turnover; Obligatory losses of nutrients; National and international recommendations on Nutrient Requirements; Recommendations for Indian by the Indian Council of Medical Research; FAO/WHO expert committee recommendations; Nutrient interrelationship; therapeutic measures of protein energy malnutrition; Adaptation and chronic energy deficiency; Regulatory processes in chronic energy deficiency; Protein and amino acid turnover; Regulation of amino acid metabolism; Disposal of dietary amino acids and roles of specific organs.

**Unit II** Micronutrients

Interrelationship, etiology and preventive measures of vitamin and mineral deficiencies toxicities; Adverse effects of Vitamins and minerals; Upper tolerable levels; Principles and interpretation of clinical laboratory methods with particular emphasis on their interpretation relative to nutritional status and disease; interaction between nutrients, infections and drugs; Functional tests of malnutrition; Nutritional assessment tools in clinical decision making.

**Unit III** Nutritional support during disease

Nutritional support, enteral tube feeding, parenteral nutrition, drugs and enteral feeding; Special considerations with nutritional support; Nutrition in surgery and trauma; The stress response to trauma on metabolism; Nutrition support in critically ill patient; Guidelines for use of formula feeds and calculation.

**Unit IV** Therapeutic nutrition

Nutrition in GI Diseases; Celiac disease, inflammatory bowel disease, Assessment of liver function - nutritional management in liver disease, acute and chronic pancreatitis, severity scores, nutritional aspects of disease affecting the skeleton, diagnostic imaging, biochemical assessment; Acute and chronic renal failure, nephrotic syndrome, transplantation; Diet and hypertension, stroke, peripheral vascular disease, and chronic heart failure; Wasting syndrome in cancer; Impact of radiation and chemotherapies; Nutritional support on clinical outcomes.

Practical : Visit to critical care wards in hospitals for familiarizing with enteral and parenteral feeding methods. Handling and deciphering the medical case sheets. Planning enteral feeding, critical care nutritional requirements for different clinical conditions. Calculating energy, protein, fat and micronutrients after nutritional assessment. Presenting case studies of medical cases. Survey of various enteral feed formulations for different clinical conditions. Report writing.

**FN-508 Nutrition Counselling** **0+2** **Sem. I**

Practical : Development of resources and dietary guidelines for counseling, procedures of nutritional counselling in clinical practice, preparing nutritional and dietary care plans for individuals and groups, Records required for follow up study, group discussion and motivation as tools to bring attitudinal changes in food selection and preparation, Counseling for Behavior Modification, Exercises on writing scientific facts in simple manner for the campaigns, exhibitions, demonstrations and workshops, Setting up counseling unit. Counselling in outpatient wards in local hospitals, Simulation techniques for counseling in selected settings, Use of dietary apps for counseling and assessing food intake.

**FN-509 Food Safety and Standards** **2+1** **Sem. II**

**Unit I** Xenobiotics

Toxicologically relevant principles of the cell and molecular biology; Dynamics and kinetics of xenobiotics; Environmental pollutants entering the food chain.

**Unit II** Food poisoning

Introduction and significance of food toxicology; Food poisoning – types, causative factors, signs and symptoms and preventive measures; Naturally occurring food toxins, their harmful effects and methods of removal.

**Unit III** Microbial and chemical toxins

Microbial toxins and food intoxication – source of contamination, effects on health, preventive measures and methods of inactivation and destruction; Chemical toxins – pesticides, insecticides, metallic and others and their residual effects, preventive measures and methods of removal.

**Unit IV** Food safety laws and standards

Food packaging material – Potential contaminants from food packaging material; Food safety laws and standards: FSSAI, FPO, ISI, Agmark, Codex Alimentarius, ISO mark for vegetarian and non vegetarian foods, eco-friendly products and others in operation.

**Practical :** Basic chemical diagnostics of poisonings based on the samples from dead animal's organs and feed. Methods of identification and quantification of poisons isolation from biological materials. Principles of sampling and sending biological materials for toxicological analysis. Basis of intravital laboratory diagnostics of acute and chronic poisonings. Evaluation of toxic effects concerning the degree and the time of exposure to axenobiotic. The determination of cholinesterase activity in the whole blood, in blood plasma and in red blood cells after the exposure to organophosphate and carbaminate insecticides. Evaluation of the effect of an antidote. Identification of nitrite and nitrate in water and in vegetables. Evaluation of nitrite and nitrate effect on haemoglobin.

**FN-510 Nutritional Challenges in Life Cycle** **3+0** **Sem. I**

**Unit I** Importance of maternal nutrition

Nutritional needs during first 1000 days and complementary foods, Influence of maternal nutritional status on outcome of pregnancy: birth weight of infant and lactation performance

**Unit I**I Human milk

Psycho-physiology of lactation; Milk synthesis and secretion; Maternal needs during lactation; Composition of colostrums and mature human milk; Milk of mothers of preterm babies; Milk of animal and formula feeds; Non-nutritional factors of human milk-immunological factors,enzymes and hormones; Human milk banking.

**Unit III** Nutrition during childhood, adolescence and adulthood

Nutritional needs of the children and adolescents; Common childhood ailments and dietaryconsiderations; Growth spurt and nutrition; Adolescent fads influencing nutrition, food preferences and nutritional problems; Nutritional requirements in adulthood; Malnutrition,mental development , learning abilities and behavior

**Unit IV** Geriatric nutrition

Overview of aging process; Nutritional variables related to the aging process; Physiology of aging; Biological markers of aging; Sociology of aging; Nutritional requirements and deficiencies in elderly; Medications and psychiatric problems in elderly; Feeding problems of elderly Immuno pathological diseases and aging; Parkinson and Alzheimer syndrome, Care of the elderly; Care-givers and community services.

**FN-511 Food Science** **2+1** **Sem. II**

**Unit I** Evaluation of food

Colloidal chemistry as related to foods; Evaluation of food by subjective and objective methods.

**Unit II** Characteristics of sugars and starches

Carbohydrates in foods sources; Characteristics of sugar; Starches - types, sources, uses and chemical characteristics; Factors effecting viscosity of starch paste; Characteristics of cellulose and

pectin; Gums in foods; Effect of cooking and processing techniques on carbohydrates; Batters and dough- types, properties.

**Unit III** Processing of cereals, legumes and animal foods. Preparation of gluten structure; Dough changes in baking; Protein in foods: Plant and animalprotein; Chemical and physical properties related to protein foods; Effect of cooking and processing techniques on animal foods – meat, fish, poultry, eggs, milk and milk products; Effect of cooking and processing of plant foods – cereals, millets, legumes, nuts and oilseeds;

**Unit IV** Processing of fruits and vegetables

Classification and importance of fruits and vegetables; Composition of fruits and vegetables. Effect of cooking and other processing methods on the nutritive value of fruits and vegetables; Food pigments; Browning reactions in fruits and vegetables; Classification and importance of beverages; Definition, classification, uses and legal aspects of food additives; Classification, nature and uses of leavening agents.

**Practical :** Microscopic structure of different starch granules. Evaluation of food by subjective and objective methods. Changes in colour, texture and flavour of foods due to processing. Product preparation using leavening agents. Physicochemical evaluation of grains like length,breadth, L/B ratio, bulk density, cooking properties, 1000 grains weight. functional properties of grains - gelatinization, water absorption capacity, oil retention capacity and water retention capacity. Sugar cookery. Smoking temperature of fats and oils. Factors effecting absorption of fats. Deep fat fried food preparation. Changes in cookery- meat, fish, poultry. Coagulationof egg, poached egg, omelette, custard, cake. Emulsion - mayonnaise preparation. Soaking,germination and fermentation of pulses.

**FN-512 Food Processing Technology** **2+1** **Sem. I**

**Unit I** Food processing techniques

Principles underlying food processing operations including thermal, radiation, refrigeration freezing and dehydration; Effect of processing on physiochemical characteristics; Principles underlying pressure modified processing (high hydrostatic pressure, hyperbaric processing, vacuum cooling, hypobaric storage).

**Unit II** Processing technologies for plant foods

Processing technology for preservation and production of variety food products during storage, handling and processing of cereals/millets and legumes, oilseeds, fruits and vegetables; Food preservation by Hurdle technology and canning technology.

**Unit III** Processing technologies for animal foods

Processing technology for milk and milk products, egg, meat, poultry and fish, convenience foods and processed foods; Technologies underlying mutual supplementation, enrichment and fortification, fermentation, malting and germination; Food additives commonly used in food industries for colour, flavour and as preservatives; Nanomaterials as food additives.

**Unit IV** Quality control in food processing

Quality control in food industry - raw materials and finished products; Waste management and sanitation in food industries; Packaging - self-cooling self-heating packaging, micro packaging, antimicrobial packaging and water-soluble packaging.

**Practical** : Effect of blanching on enzymatic activity and volume occupation. Effect of refrigeration and freezing on quality of fruits and vegetables. Dehydration of fruits and vegetables. Canning of fruits and vegetables. Preparation of fruit candy, squash, nectar, malt beverages and quality evaluation with respect to FPO. Clarification of juice using various methods (chemical, enzyme and fining agents). Malting of green gram, moth bean- enzymatic activity determination. Preparation of Paneer and curd and its quality evaluation. Quality evaluation of egg and fish. Effect of chemical preservation on storage quality of food (bread, cake). Storage of nuts and oil seeds under vacuum packaging. Packaging of fruits and vegetables for transportation distance market using corrugated fibre boxes. Transportation of fresh fruits and vegetables using cushioning system and fibre board. Visit to food processing unit.

**FN-513 Human Physiology** **3+0** **Sem. I**

**Unit I** Circulatory system

Overview of anatomy and functions of human body; Reticuloendothelial system- functions, classification; Lymphatic system- functions, circulation; Circulatory system- blood and composition blood cells, development and function of blood cells, blood clotting, blood grouping and haemoglobin, Heart - anatomy, cardiac cycle, blood pressure and factors affecting blood pressure.

**Unit II** Respiratory system

Respiratory system- anatomy, physiology and mechanism of respiration, regulation of respiration; Digestive system- anatomy of gastrointestinal tract and accessory organs, digestion and absorption of food, regulation of appetite.

**Unit III** Excretory system

Excretory system- anatomy and functions of kidney, formation, composition and excretion of urine; Endocrine glands, mode of action of hormones.

**Unit IV** Reproductive system

Reproductive system- structure and functions of male and female reproductive organs; Anatomy and functions of nervous and musculoskeletal system.

**FN-514 Institutional Food Service Management** **1+1** **Sem. II**

**Unit I** Food service management

Types of food services- organization and management. Tools of management; FSSAI and CODEX guidelines.

**Unit II** Record keeping

Personnel recruitment and management; Books, records and record keeping; Cost control in food services; Menu planning; HACCP and QMS

**Unit III** Quantity food production

Meal services management; Types of services; Quantity food production; Principles involved in development of recipes in large scale cooking; Standardization of recipes; Food storage, Utilization of left-over foods.

**Unit IV** Planning of food service unit

Types of kitchens; Planning of layout and equipment for food services; Sanitation and hygiene in handling foods; Personnel hygiene and its importance; Organization of spaces.

**Practical :** Standardization of basic recipes: planning and preparation, Modification in basic recipes, Use of left-over foods, Standardization of health foods, visit to different types of food service institutions and study the organization, physical plan and layout, food service equipment, sanitation and hygiene, Practical experience in organization and management of a college cafeteria / hotels, Setting of canteens with formal and informal table setting, Scale production of standardized recipes, Menu planning for snack bars, canteens, residential hostels and hospitals, Cost analysis.

**FN-591 Seminar** **1+0**

**FN- 599 Master's Research** **0+30**

**Ph.D. Courses**

**FN-601 Macronutrient Metabolism** **3+0** **Sem. II**

**Unit I** Macronutrients

Digestion, absorption and metabolism of carbohydrates, proteins and lipids; Inborn errors of metabolism; Degenerative diseases - diabetes, obesity, atherosclerosis, hyperlipidaemia and hypertension; Glucose homeostasis determined by insulin/glycogen ratio; low carbohydrates diet and its metabolic consequences.

**Unit II** Dietary fibre

Glycaemic Index and load; Dietary fibre and its impact in various physiological disorders; Hypoglycaemic action of foods.

**Unit III** Proteins

Classification of protein, new discoveries in protein and their functions (protein in immune system, biological buffers and carriers); Evaluation of protein quality- in vitro and in vivo methods, animal and human bioassays; Amino acid pool, protein turnover in man with special reference to body size, age and various nutrition and pathological conditions; Novel food sources of protein; Role of hormones in protein metabolism; Effect of dietary protein on cardiovascular disease and cholesterol metabolism; Adaptation of body to low intake of energy and protein.

**Unit IV** Lipids

Hypolipidemic action of MUFA, PUFA and oxidation products of cholesterol; Effect of saturated fatty acids and trans fatty acids in lipid metabolism, role of reversal diet in cardiovascular disorders; Causes, prevention and treatment of hyperlipidaemia.

**FN-602 Micronutrient metabolism** **2+0** **Sem. II**

**Unit I** Vitamins

History, chemistry, distribution and functions of vitamins; Absorption, transportation, metabolism of vitamins; Nutritional requirements of vitamins; Deficiency manifestations of water soluble vitamins; Deficiency manifestations of fat soluble vitamins; Causes of vitamin deficiencies in India; Hypervitaminosis of water-soluble vitamins; Hypervitaminosis of fat- soluble vitamins; Vitamin fortification and supplementation; Methods of assay of vitamins; Interaction with other nutrients, antagonists and analogues of vitamins; Assessment of vitamin status of population.

**Unit II** Minerals

Causes of macro and micro mineral deficiencies in India; Chronology, chemistry and distribution of minerals; Functions, absorption, transport and metabolism of minerals; Deficiency manifestations of minerals; Nutritional requirements of minerals; Methods of assay of minerals; Interactions of minerals with other nutrients, antagonists and analogues of minerals; Assessment of mineral status of population; Mineral fortification and supplementation; Metalloenzymes. Antioxidants and their relationship with aging, cancer and various non-communicable diseases.

**Unit III** Heavy metal toxicity

Harmful effects of major mineral pollutants on health - mutagenicity, carcinogenicity and heavy metal toxicity; Heavy metal toxicity;

**Unit IV** Trace elements

Trace minerals - their chronology, chemistry, distribution. Functions of trace minerals. Absorption and metabolism of trace minerals. Requirements of trace minerals. Deficiency manifestation and interaction of trace minerals. Use of mineral isotopes/ tracers in nutritional studies.

**FN-603 Nutrition and Agricultural Interface** **3+0** **Sem. II**

**Unit I** Food production and consumption

Food situation in India and in the world; Food production and consumption trends; Food balance sheets; Role of nutrition in agricultural planning and national development.

**Unit II** Food distribution

Linkages between agricultural practices and food production, distribution and nutritional status; Factors affecting food distribution at macro and micro level; Per capita food availability and consumption; Food and Nutrition security at national and household level; Role of agriculture in enhancing food security; Food crop failure and malnutrition.

**Unit III** Farming systems

Poverty and vicious cycle of low food production; Effect of food production and economic policies on food availability; Impact of physical resources, farming systems, cropping system, inputs and manipulation, agricultural marketing system, post-harvest processing of foods on food and nutrition situation; Implementation of nutrition policy.

**Unit IV** Agricultural programmes

Sustainable food systems, nutritional impact of agricultural programmes, food price control and consumer subsidy; Contribution of National and International organization in agricultural development.

**FN-604 Global Nutritional Problems** **2+0** **Sem. I**

**Unit I** Food consumption

Food consumption pattern, diet quality and availability of the fortified and supplemented foods, ultra processed foods of underdeveloped, developing and developed countries

**Unit I**I Nutritional deficiency diseases

An overview of world nutrition situation and assessment of problems of developing and developed countries in light of prevalence, aetiology, indicators and preventive measures.

**Unit III** Health programmes

Nutrition and health programmes to alleviate malnutrition, role of national and international organizations.

**Unit IV** Health care policies

Impact of health care polices and delivery systems; Micronutrients, food fortification and supplementation.

**FN-605 Nutrition in Calamities** **2+0** **Sem. I**

**Unit I** Calamities and under nutrition

Starvation in emergencies arising out of, drought, floods, earth quakes, locust, war, wrong policies and poverty and climatic changes, conflict and global economic volatility, historical perspectives.

**Unit II** Food needs during emergencies

Effect of inanition, short, medium and long- term emergencies on food and nutrient intake, precautions against food shortage; cost control of basic commodities, Population groups most vulnerable to under nutrition; Food needs at national level during normal emergencies. Nutrition surveillance

**Unit III** Nutritional deficiency diseases

Major nutritional deficiency diseases in emergencies, mobilization of local resources, general fund distribution, mass and supplementary feeding, therapeutic feeding, social funds; Nutritional Indices and reference standards; Preventing and handling donations in emergencies

**Unit IV** Hygiene and sanitation

Control of communicable diseases, public health and hygiene problems during emergencies.

**FN-606 Maternal and Child Nutrition** **2+0** **Sem. I**

**Unit I** Nutrition and reproduction

Nutrition challenges, physiological changes, teenage pregnancy and gestational diabetes, nutrient needs, factors affecting nutrition of the women and children.

**Unit II** Nutritional deficiencies

Needs and problems of lactating women, fetal malnutrition and low birth weight, nutrition and parasites, children with special needs, Protein energy malnutrition, vitamin A, iron, vitamin D, calcium and other common deficiencies, significance of stem cell and cord blood.

**Unit III** Feeding practices

Formula feeding and supplements, lactation and breast feeding in the community, HIV and breast feeding; drug abuse and breast feeding. Human milk banks, IYCF guidelines, WHO breast feeding recommendations

**Unit IV** Overnutrition and undernutrition

International programs regarding child and maternal health initiative to prevent overnutrition and undernutrition.

**FN-607 Hormones and Enzymes** **2+0** **Sem. II**

**Unit I** Hormones

History, chemistry, endocrine and exocrine secretion of hormones, organs of secretion, metabolism, mechanism of action, regulation and sites of action, biological effects and interaction.

**Unit II** Enzymes

Enzyme pathways in normal functions of the heart, pancreas, gastrointestinal and hepatic functions and kidneys.

**Unit III** Metabolic disorders

Altered hormone and enzymatic pathways in obesity, reproductive functions, renal disorders, Gastrointestinal disorders.

**Unit IV** Degenerative diseases

Altered hormone and enzymatic pathways in hypertension, cardiovascular diseases, diabetes and cancer.

**FN-608 Energy Metabolism** **2+0** **Sem. II**

**Unit I** Bioenergetics

Scope and application of bioenergetics for human nutrition; Energy stores in man; Components of energy; Basal metabolism, energy cost of various activities; Factors affecting energy expenditure.

**Unit II** Energy expenditure

Direct and indirect methods of assessing energy expenditure; Factors affecting energy requirements; Assessment of energy requirements.

**Unit III** Regulation of metabolism

Thermogenesis, metabolic regulation; Weight control and obesity-role of adipose tissues; Effect of hormones on energy metabolism.

**Unit IV** Hunger

Mechanism of hunger; Psychological and physiological factors associated with adiposity.

**FN-609 Application of Biotechnology in Food Science and Nutrition** **3+0** **Sem. I**

**Unit I** Food science and biotechnology

History, processes and products of biotechnology, application of biotechnology in production of nutritious foods.

**Unit II** Product development

Role of biotechnology in enzymology and product development, fermentation process, fruit juice extraction, genetic improvement of food grade microorganisms.

**Unit III** Nutraceuticals

Nutritional significance of food products developed by biotechnological techniques.

**Unit IV** Constraints in food biotechnology

Scientific, technological and resource constraints in biotechnology; important factors affecting development in biotechnology.

**FN-610 Recent Trends in Food Science and Technology** **3+0** **Sem. I**

**Unit I** Macro and micronutrients

Recent advances in the field of carbohydrates, lipids, proteins, vitamins and minerals inrelation to food science; Nutrigenomics, incorporating genetics into dietary guidance.

**Unit II** Food analysis

Recent advances in the field of food analysis and food fortification.

**Unit III** Advanced techniques

Membrane technology: micro-filtration, ultra-filtration, nano-filtration, reverse osmosis and their applications in food industry; Supercritical fluid extraction- concept and extraction methods; Microwave and radio frequency processing- mechanism and application in food processing; Hurdle technology-concept and its applications.

**Unit IV** Foods of future

Food processing and product development; regulating; food processing and preservation through Total Quality Management (TQM) and Hazard Analysis and Critical Control Points (HACCP); Genetically Modified Foods (GM) foods and their health implications, functional foods and organic foods

**FN-691 Seminar I** **1+0**

**FN-692 Seminar II** **1+0**

**FN-699 Ph.D. Research** **0+75**

# NUTRITION AND DIETETICS/ FOOD NUTRITION AND DIETETICS

## B.Sc. (Hons) Nutrition and Dietetics / Food Nutrition and Dietetics - 4 year Programme

**N Diet. 101/ FND 101/ FN101 Principles of Human Nutrition** **3+0** **Sem. I**

Introduction and overview of basic principles of nutrition. Relationship of nutrition to health, growth and human welfare. Definitions of terms used in nutrition- Recommended dietary allowances, balanced diet, health, functional foods, phytochemicals, nutraceuticals, dietary supplements, food groups. Energy-units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of body, physical activity and thermogenic effect of food. BMR- methods of measurement, factors affecting BMR. Digestion and absorption of carbohydrates, lipids and proteins. Carbohydrates-Types, functions, sources, requirement, health conditions affected by carbohydrates, significance of dietary fibre. Lipids- Types, functions, sources, requirement, health problems associated with lipids proteins-Types, functions, sources, requirement, quality evaluation, improvement and deficiency and protein energy malnutrition. Vitamins- Classification, functions, sources, requirement, deficiency and toxicity of fat soluble-(A, D, E, K), (water soluble – C, B Complex (thiamine, riboflavin, niacin, B6, Pantothenic acid, B12 and folic acid). Minerals- Classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc, bioavailability and factors calcium and iron. Water-functions, sources, distribution in body water balance and electrolyte balance.

**N Diet.102 / FND 102 Fundamentals of Food Science** **2+1** **Sem. I**

Cooking- Objectives, cooking methods, their types, merits and demerits. Cereals and millets - Structure, composition, processing techniques, effect of heat and acid, functions of starch in the cookery. Legumes, nuts and oil seeds - Composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - Types, composition, pigments, changes caused by heat, acid and alkali. Milk and milk products – Composition, types, products, effect of acid on milk cookery, uses and functions. Egg - Structure, composition, grading of egg, function and changes during cooking. Meat, poultry and fish-Types, structure, composition, pigments, factors affecting tenderness, post-mortem changes and changes during cooking. Sugars- Types, composition, manufacturing process, effect of heat and acid, functions in cookery. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques, rancidity of fats; Brief overview of beverages; Condiments and spices, importance in daily life.

**Practical :** Orientation to kitchen equipment and their uses, weighing and measuring food items and identification of the food grains, condiments and spices. Introduction to cooking methods. Cereal cookery-Practical exercise on dextrinization and gelatinization of rice starch, gluten formation in wheat. Legumes-identification and cooking methods. Nuts and oilseeds- use in food preparations. Vegetable cookery-different preparations with vegetables and effect of heat and alkali on pigments. Preparation of soups, salads and beverages. Milk and milk products- use in various preparations. Egg cookery- preparations showing functions of egg and various ways of using egg. Meat, poultry and fish cookery - preparations involving various methods of cooking. Sugar- preparations showing functions of sugar in cookery. Fats and oils - demonstration of smoking point and use in various preparations

**N Diet.103 / FND 103 Food Hygiene and Sanitation** **2+1** **Sem. I**

Concept and significance of hygiene and sanitation in relation to food industry. Food storage – general guidelines and storage of specific foods. Principles of hygiene and sanitation – sanitary procedures while preparation, cooking, holding, serving and displaying food and specific food operations. Sources of food contamination. Sanitation pf physical plant (premises), sanitation of equipment and cleaning procedures. Personal hygiene and food handling habits of personnel. Water – supply sources and impurities of water. Water purification methods – domestic and industrial. Food and water borne infections – prevention and control. Regulatory laws – environmental pollution, sanitary regulations and standards.

**Practical:** Identification of microorganisms. Preparation of slides. Preparation of media. Collection of water samples. Testing of water - Physical quality and bacteriological quality. Survey of hygienic and sanitary conditions in food shops/food vendors. Report writing.

**N Diet.104 / FND 104 Methods of Cookery** **2+1** **Sem. II**

Kitchen attire and equipment's. Terminology used in cooking. Cooking of food – heat and heat transfer methods. Effect of cooking on food and its nutritive value. Principles and practices of boiling, simmering, steaming, frying, stewing, pressure cooking, roasting, baking, braising, grilling, infrared, microwave cooking and combined methods of cookery for different food groups. Basics of culinary practices. Thickening and binding agents. Flavoring stocks, essence, glazes, sauces, soups and garnishes.

**Practical :** Preparation of recipes from different food groups such as cereals, pulses, eggs, vegetables, fruits and milk. Preparation of food product**s** using various cooking method**s**- boiling, steaming, frying, stewing, roasting, braising, grilling, microwave cooking and methods in combination.

**N Diet.105/ FND 105 Food Processing and Packaging** **2+1** **Sem. II**

Indian and global scenario on food production and processing. Scope of food processing. Food processing and preservation techniques for cereals, pulses, oilseeds, fruits, vegetables, milk, meat, fish and poultry. Impact of processing on physical, chemical and nutritional quality of foods. Shelf life of processed foods. Factors affecting quality of processed foods. Food Packaging - Indian and global scenario, classification, functions, requirement and packaging material. Principles in the development of protective packaging. Laws related to packaging. Shelf-life of packed food, special problems in packaging of foodstuffs. Packaging of water, beverages.

**Practical** : Market survey for packaged/ processed food stuffs. Processing of cereals and legumes: Milling, dehulling, parboiling, roasting, puffing, parching and malting etc. Processing of fruits and vegetables: juices, blanching and freezing. Pasteurization and homogenization of milk. Packaging of liquid milk. Preparation of curd and yogurt. Visit to chilling centre and dairy plant . Estimation of shelf- life of packaged food stuffs.

**N Diet.106/ FND 106 Food Preservation and Storage** **2+1** **Sem. II**

Scope of food preservation and storage. Classification of foods on the basis of shelf life. Food spoilage - causes and factors affecting. Selection and purchase of foods for preservation. Quality requirement of raw materials for preservation. Primary and secondary processing. Grain storage. Principles and methods of food preservation: Drying, high temperature, low temperature and irradiation. Food preservation by natural and chemical food preservatives. Traditional and modern methods of preservation and storage. Packaging and packaging materials, labelling and costing of different products. Food additives, anti-oxidants, colouring matter and emulsifying agents.

**Practical** : Market survey of raw and preserved foods. Drying of blanched and unblanched fruits and vegetables by solar, sun and oven drying methods. Domestic preservation of foods by freezing. Preparation and storage of preserved products. Squash, cordial, crush, jams, jellies, marmalade, candy, preserves, pickles with and without oil, chutneys, ketchup, sauces, candies, toffees, cheese and syrup. Shelf life and sensory evaluation of developed products. Demonstration on canning and bottling of fruits and vegetables. Demonstration on storage of food grains. Visits to food processing and preservation units, canning and bottling units, grain storage institute, dairy plant and FCI godown.

**N Diet. 201/ FND 201 Normal Nutrition and Meal Planning** **3+1** **Sem. I**

Importance and basic principles of meal and menu planning. Classification of vegetarianism. Factors influencing food intake and food habits. Factors to be considered while planning meals and menus for individual and family. Factors affecting food requirements of individuals, families and different groups of people. Steps involved in meal planning. Food groups and their use in meal planning. Food exchange list and its use in diet planning. Importance of balanced diet. Recommended dietary allowances of macro and micro nutrients for different age groups. Food and nutrient requirement of adults (male and female of all activities level), pregnant women, lactating women**,** infants and normal infants. Breast feeding, advantages of breast feeding, prelacteal feeding, breast feeding during illness, feeding of pre term baby,

feeding problems. Weaning and complementary feeding. Food and nutrient requirement of pre-school children, school age children, adolescents, age people. physiological and psychological factors affecting the diet plan.

**Practical** : Grouping of foods based on richness of nutrients and quantifying foods to give uniform content of each nutrient. Standardization of serving size, portion size and costing. Planning and formulation of food exchange lists. Planning, preparation and nutrient calculation of diets of preschoolers, school going children, adolescents, adults, pregnant and lactating women and elderly. Packed lunches for school children. Introduction to different computer programmes pertaining to nutrient analysis.

**N Diet. 202/ FND 202 Nutrition and Immunity 3+0 Sem. I**

Immune systems - the defense mechanisms of the body. Role of nutrients in immune functions. Undernutrition, host defense mechanisms and risk of infection. Infections and undernutrition - causes and consequences. Influence of infections on nutrition and susceptibility to infection. Role of nutrients in prevention of risk of infections. Childhood mortality associated with infectious diseases of gastro-intestinal tract and lungs. Age related immune depression. Role of nutraceuticals and functional foods. Nutrition, HIV/AIDS and Tuberculosis. Probiotics, prebiotics and immunity. Food allergy.

**N Diet. 203/ FND 203 Food Product Formulations and Development 2+1 Sem. I**

Awareness about the dietetic foods available in the market. Basic principles of food product development. Sensory properties of foods and their role in product development. Bulk food preparation for food institutions and enterprises- servings, nutritive value and costing. Evaluation of formulated foods using objective and subjective methods. Selection and training of judges. Development of score cards and data analysis . Consumer evaluation- development of schedule and data analysis. Costing and cost control. Packaging materials, labeling and shelf life of formulated products. Food quality regulations and standards, food safety and quality control issues in product development. Product formulation and development for general and therapeutic use.

**Practical** : Survey on availability of dietetic foods in the market. Selection and modification of food products to be developed. Formulation, standardization, objective and subjective evaluation of the products. Sensory evaluation- methods, training of judges and score card preparation. Evaluation of consumer acceptability. Packaging- suitability of different packaging materials, labeling and shelf life of developed dietetic foods.

**N Diet. 204/ FND 204 Cereals , Pulses and Oilseeds: Preparation and Utilization 2+2 Sem. I**

Major cereals and millets of India- structure , composition, storage and varietal differences. Suitability of commercial grains for processing. Wheat types and hardness - soft, hard and durum wheat. Suitability of wheat flour for particular end use. Rice- structure, composition, milling, parboiling, ageing, cooking, processing, fermentation and by-products. Maize, barley, oats and millets- structure, composition, malting, milling and by- products. Utilization of all commercial grains. Major pulses of India. Primary processing of pulses- cleaning, drying, storage and control of storage pests. Secondary processing methods-dehulling, small and large scale processing. Nutrient losses during processing. Processing methods like soaking, germination, cooking and fermentation. Major oilseeds of India and their utility. Pre treatments and oil extraction from different oilseeds. Refining, bleaching, deodorization and hydrogenation processes of edible oils. Anti-nutritional factors and toxic constituents of pulses and oilseeds. Production technology of oilseeds/ pulses- meals/flours, protein concentrates , isolates and by-product utilization.

**Practical** : Physico-chemical properties of grains. Estimation of amylase and gluten content. Chemical tests- sedimentation test, flour swelling volume and starch gelatinization. Preparation of wheat products-bread and biscuits. Preparation of fermented rice products. Processing of pulses- soaking, dehulling, germination and fermentation**.** Preparation of snacks based on pulses and oilseeds. Preparation of recipes from germinated and fermented pulses. Visit to flour mills, rice mills and bakery units. Visit to traditional /modern *dal* mills and oil mills.

**N Diet. 205/ FND 205 Nutrition Through Life Cycle** **2+** **Sem. II**

Infancy- Role of nutrition on physical and mental development, rate of growth-weight as an indicator, assessment of growth, nutrient requirement during infancy, feeding of infants, value of breast feeding on infants, breast feeding versus artificial feeding, types of milk and their use in infant feeding. Weaning and supplementary foods, weaning practices in community, feeding of premature and low-birth-weight infants. Nutritional disorders and common ailments in infancy. Feeding the sick child, immunization schedule and growth charts. Preschool age- Physical growth and mental development, prevalence of malnutrition in preschool years and food habits, nutritional requirements during preschool age and supplementary foods. School age- Physical growth and mental development, nutritional requirements during school age, specific problems in feeding school children Adolescence- Physical and physiological changes, nutritional requirements, food preferences and nutritional problems, growth spurt and nutrition, fads influencing nutrition. Adulthood- Sex, occupation and income, nutritional requirements, biological and nutritional consequences. Nutrition, work capacity and physical fitness. Pregnancy- Physiological changes in pregnancy, weight gain during pregnancy, food and nutrient requirements. Complications of pregnancy and their nutritional management, impact of nutrition on the outcome of pregnancy. Nutritional need of fetus during different stages of fetal cell growth and maternal nutritional needs. Psycho-physiology of lactation, milk synthesis and secretion, maternal needs during lactation, composition of colostrum and mature human milk, milk of mothers of pre-term babies. Non-nutritional factors of human milk, immunological factors, enzymes and hormones. Human milk banking. Elderly- Physical and physiological changes, nutritional requirements, problems of old age, nutrients influencing aging process

**N Diet. 206/ FND 206 Community Nutrition** **2+2** **Sem. II**

Basic concept of community nutrition. Role of nutritionist in improving community nutrition. Food habits, taboos and influencing factors. Mortality and morbidity pattern of vulnerable groups and its causes. Malnutrition- definition, causes and classification of grades. Assessment of nutritional status using dietary survey, anthropometry, clinical symptoms and biochemical methods. Major nutritional problems prevalent in community– protein energy malnutrition, vitamin A deficiency iron deficiency anaemia, , iodine deficiency and fluorosis. Role of national and international agencies in improving nutritional status of the community. Objectives, principles and importance of nutrition education in a community. Nutritional surveys- National Nutrition Monitoring Bureau. Nutrition surveillance. Communication techniques- process and components. Classification and use of audio visual aids- Electronic, non projected and three dimensional. Planning, selection and evaluation of audio visual aids in developing appropriate messages for target groups.

**Practical** : Assessment of nutritional status of an individual/community using anthropometry and dietary survey. Visit to local health centers to identify clinical signs and symptoms of nutritional problems. Visit to Anganwadi centres , rural and urban schools to evaluate mid day meal programme. Preparation and use of audio- visual aids - Charts, posters, calendars, flipcharts, pamphlets and models. Planning, implementation and evaluation of nutrition education programme for a target group. Use of computers in assessing nutritional status of the community.

**N Diet. 207/ FND 207 Public Health Nutrition** **3+1** **Sem. II**

Concept and scope of public health. Public health problems of India. Aetiology, prevalence and prevention of nutrient deficiency diseases. Nutritional epidemiology- Objectives, measurements and methods. National Health Policy and National Nutrition Policy (NNP). National nutrition programmes relevant for public health-Vitamin A deficiency disorder control programme, National diarrhoeal disease control programme, National iodine deficiency disorder control programme, Iron deficiency anemia prophylaxis programme, National malaria eradication programme, National immunization programme, National programme for control of tuberculosis, National leprosy eradication programme, National AIDS control programme, National guinea worm eradication programme, National kala azar control programme. Factors affecting implementation of programmes in rural areas. Modulating factors in nutrition for public health and child care. Existing picture of child health, objectives and imaginative approach to child care. Care of infants and women. Hereditary disorders. Health problems of aged and their care. Special care and priority for mentally handicapped. Occupational health and industrial health policy. Traditional medicine, vegetarianism, health foods, genetically modified foods and their relevance in human health.

**Practical** : Epidemiological approach to study individual disease in a community. Analysis of data and report writing. Discussion for preventive and therapeutic strategies. Public health campaign in a village.

**N Diet. 208/ FND 208 Introduction to Clinical Nutrition 2+1 Sem. II**

Aetiology, metabolic changes and clinical diagnosis in various nutrient deficiency diseases: protein energy malnutrition, vitamin A, B complex, C and D, calcium , iron Zinc, iodine and fluorine . Aetiology, metabolic changes, clinical manifestations and complications in degenerative diseases- obesity, diabetes, cardiovascular diseases- atherosclerosis and hypertension; renal disorders – nephrosis, acute and chronic ; liver disorders- hepatitis, jaundice and cirrhosis and cancer. Interpretation of blood and urine report in different disease conditions.

**Practical** : Identification and interpretation of clinical signs of nutritional deficiency diseases sampling of blood and urine for nutritional status. Estimation of haemoglobin. Estimation of glucose in blood and urine in normal and diabetic persons. Estimation of lipid profile in normal and heart patients. Estimation of serum retinol, total protein and serum albumin. Visit to a clinical laboratory.

**N Diet. 209/ FND 209 Therapeutic Nutrition-I 2+2 Sem. II**

Importance of therapeutic meal planning and factors to be considered in meal planning. Use of food groups and exchange list in therapeutic meal planning. Importance and modification of normal diets to therapeutic diet. Causes, symptoms and dietary management in Infections, acute and chronic fevers; gastrointestinal disorders- diarrhoea, constipation, peptic ulcers ulcerative colitis, diverticulitis, irritable bowel disease, malabsorption syndrome; liver diseases and gall bladder diseases -jaundice, hepatitis, cirrhosis, hepatic coma, cholelithiasis ; eating disorders- Anorexia nervosa, bulimia, underweight, overweight and obesity.

**Practical** : Market survey for determining cost of locally available common foods. Standardization of serving sizes for different food items. Planning and preparation of soft , liquid and bland diet, ORS and therapeutic diets for typhoid, tuberculosis, influenza, malaria and AIDS. Planning and preparation of diets for gastrointestinal disorders i.e. diarrhoea, constipation, peptic ulcers, GERD, ulcerative colitis, diverticulitis, irritable bowel disease and malabsorption syndrome. Planning and preparation of diets for liver and gall bladder diseases- Jaundice, hepatitis, cirrhosis, ascites, hepatic coma and cholelithiasis. Planning and preparation of diets for eating disorders- anorexia nervosa, bulimia, underweight, overweight and obesity . Use of computer software for nutrient calculations of therapeutic diets.

**N Diet. 210/ FND 210 Fruits and Vegetables: Preparation and Utilization 2+1 Sem. II**

Fruits and vegetables- importance and scope in human diet. Harvesting and processing of fruits and vegetables, Selection of raw material for preservation and processing. General principles involved in preservation of fruit and vegetable products. Specification of processed products. Post- harvest practices and changes. Carbonated beverages, non-alcoholic beverages and fruit juice concentrates. Pickles, vinegar, tea, coffee and cocoa products. Wine and fermentation technology.

**Practical** : Evaluation and grading of pectin. Preparation and quality evaluation of fruit jam, jelly, marmalade, preserve, candy, RTS , squash and syrup with fruits of regional importance. Preparation of grape raisin, dried fig and dried banana. Processing of tomato products. Preparation and evaluation of dehydrated vegetables. Preparation of fruit cheese, pickle / mixed pickle, dried ginger and mango powder (amchur).

**N Diet. 211/ FND 211 Sports Nutrition and Physical Fitness 3+0 Sem. II**

Concept of sports nutrition. Evolution and growth of sports nutrition as a discipline. Overview of nutritional management vis-a-vis physical fitness, techniques and methods of measuring physical fitness. Body composition -methods of measuring and factors affecting it. Energy metabolism - concept, importance and influencing factors. Techniques to measure energy expenditure and energy intake. Nutritional requirements of sports personnel involved in various sports. Basic exercise physiology and biochemistry -physiological and metabolic changes during and after sports activity. Macronutrients metabolism in exercise - carbohydrates and fats -fueling before, during and after exercise. Effects of dehydration and rehydration in exercise and role of water and electrolytes in performance. Vitamin metabolism in sports.

Free radicals in exercise and role of antioxidants. Essential minerals, trace elements and their metabolism in sports. Nutrition supplements and ergogenic aids. Special consideration in sports nutrition- women, young, diabetic and vegetarian athletes. Amenorrhea in athletes - role of diet. Winning recipes for peak performance.

**N Diet. 301/ FND 301 Therapeutic Nutrition-II 2+1 Sem. I**

Principles and objectives of therapeutic diets. Overweight and obesity- causes and consequences. Body weight management. Cardiovascular diseases- Causes, symptoms and dietary management in atherosclerosis, hypertension, myocardial infarction, cerebrovascular stroke and congestive heart failure. Diabetes mellitus and gout - Types, causes, symptoms and dietary management. Renal disorders – Physiology of kidney, causes, symptoms and dietary management in nephrosis, nephritis, acute and chronic renal failure, renal calculi and dialysis. Respiratory disorders – Acute and chronic COPD. Cancer- Causes, symptoms and dietary management. Eating disorders. Management of severe acute malnutrition in children. Dietitian – Definition, role and responsibilities of a dietitian, code of ethics, competencies of dietitian. Registered Dietitian . Management of dietetics department, guidelines and requirements for establishing a diet counseling centre. Techniques for diet counseling.

**Practical** : Planning and preparation of diets for patients suffering from atherosclerosis, hypertension, myocardial infarction, cerebrovascular stroke, congestive heart failure, different types of diabetes mellitus, gout. Diet planning and preparation for various eating disorders i.e. anorexia nervosa, bulimia, underweight, overweight and obesity. Planning and preparation of diets for renal disorders i.e. nephrosis, nephritis, acute and chronic renal failure, renal calculi and respiratory disorders – Acute and chronic COPD, acute respiratory disorders. Setting up a unit for nutrition counseling and role play exercises for counseling.

**N Diet. 302/ FND 302 Food Chemistry 3+1 Sem. I**

Properties of foods- solubility, vapour pressure, boiling point, freezing point, osmotic pressure, viscosity, surface tension, specific gravity, oxidation and reduction. Acids, bases and buffers. Composition of foods- classification, structure and properties of carbohydrates, proteins and lipids. Water - physical properties: free, adsorbed and bound water. Properties of minerals and vitamins. Structure and properties of pigments - chlorophyll, anthocyanins, flavanoids, tannins, betalains, quinones, carotenoids, myoglobin, haemoglobin, flavouring compounds, terpenoids, flavanoids and sulphur compounds. Enzymes, enzyme inhibitors, enzymatic browning and enzymes in food processing. Classification, structure, composition, processing and its effects on cereals, pulses and oilseeds, milk, fruits, vegetables, eggs, meat and poultry. Sugars, sweeteners, non nutritive sweeteners and their reactions. Food additives- antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavours, flavour enhancers, humectants, anti-caking agents, leavening agents, nutrient supplements, preservatives, stabilizers and thickeners.

**Practical** : Weight and volume of food stuffs- flours, sugar, fats and eggs. Preparation of standard solutions- percentage volume by volume, percentage weight by volume, molar and normal. Effect of solutes on boiling point of different solutions. Qualities of flour- absorptive power, gluten and effect of other ingredients on gluten. Crystallization of sugars from syrups. Tests for unsaturation and rancidity of fats- Iodine value, peroxide value and smoke point. Effect of heat on proteins.

**N Diet. 303 / FND 303 Milk and Milk Products: Preparation and Utilization 2+1 Sem. I**

Introduction, importance, scope, brief history and present status of milk industry in world. Composition and nutritive value of milk and milk products- physical state, colour, flavor, acidity, pH, density, specific gravity and freezing point. Processing of milk- collection, chilling, standardization, pasteurization, homogenization and bactofugation. Types of milk- sterilized, homogenized, flavoured, and standardized, reconstituted/re-hydrated, recombined and toned milk. Value addition of fluid milk. Milk products- butter, *ghee*, *khoa*, cheese. Principles of dehydration. Quality control aspects of milk- status of antibiotics, pesticides, heavy metals. Microbiological defects in milk and milk products, their causes and prevention. Good manufacturing practices and implementation of HACCP standards. Indian standards for milk and milk products as per PFA, BIS, AGMARK and FSSAI. Cleaning and sanitization procedures. Grading of milk.

**Practical** : Sampling of milk. Estimation of fat, SNF, TS and platform tests and separation of cream. Detection of adulterants .Preparation of milk products- butter, *ghee*, *paneer*, *channa,* icecream, *khoa, burfi*, flavoured milk, *rasogulla* etc. Visit to modern milk processing and manufacturing plants.

**N Diet. 304/ FND 304 Food Standards and Quality Assurance 3+1 Sem. I**

Importance of quality control and assurance. Food quality and quality attributes - classification and their role in food quality. Objectives and functions of quality control. Principles of quality assurance and quality assessment of raw materials. National and International food standards. Food additives- preservatives, colourants, emulsifiers, antioxidants and stabilizing agents. Various methods for quality assessment of different foods. Grading and marketing standards and specification for finished products. Food adulteration- introduction, assessment and prevention. Sensory analysis- general testing conditions, requirements of sensory laboratory, organizing sensory evaluation programme, selection of sensory panelists and factors influencing sensory quality parameters- size, shape, texture, aroma, taste, color and gloss. Different tests for sensory evaluation– discrimination, descriptive, affective, flavour profile and ranking tests. Methods of sensory evaluation of food products, statistical analysis of sensory and objective analysis data. Introduction to HACCP and its implementation in food industry. Food safety and quality control. Food grade standards for different processed products.

**Practical** : Sampling techniques for collection of agricultural, horticultural and animal foods. Collection of food samples from different sources, physical examination and grading of grains, spices etc for quality. Sensory evaluation of a food product. Sensory evaluation techniques- duo-trio test and score card method. Demonstration of objective tests for quality evaluation. Detection of food adulteration in grain samples, spices, oils and milk. Collection of food products with artificial colouring and checking for quality. Visit to quality control lab.

**N Diet. 305/ FND 305 Nutrition in Disaster Management 3+0 Sem. I**

Definition and historical perspective of national disasters. Starvation in disasters arising out of drought, floods, earth quakes and war policies. Effect of short, medium and long term emergencies on food and nutrients intake. Major nutritional deficiency diseases in disasters. Food needs at national level during emergencies and precautions against food shortage. Nutritional relief- general and selective feeding programmes. Prevention, treatment and control of communicable diseases. Public health and hygiene problems during emergencies. Government strategies to combat malnutrition during national disasters.

**N Diet. 306 / FND 306 Nutritional Strategies in ICU 2+1 Sem. I**

Principles and modes of feeding. Enteral nutrition - methods of enteral feeding. Formulae for enteral feeding. Feeding requirements. Care of solutions. Recording and monitoring. Advantages of tube feeding. Parenteral nutrition - methods of parenteral feeding. Total parenteral nutrition formulae for children and adults. Complications of total parenteral nutrition. Hospital nutrition support service. Pre-operative nutritional assessment. Pre and post-operative diet. Immunonutrition.

**Practical** : Visit to dietary department of hospital to observe different diet formulae. Visit to ICU of hospital for observing different types of feeds given to patients. Preparation of diets using different formulae.

**N Diet. 307/ FND 307 Fundamentals of Nutraceuticals and Health Foods 3+0 Sem. II**

Nutraceuticals- Concept and definition. Synonymous terms – functional foods, health foods, bioactive compounds and phytochemicals. Relationship between nutraceuticals, foods and medicines. Classification of nutraceutical substances based on food sources and mechanism of action. Classification and importance of functional foods. National and international standards for regulatory issues of labeling and health claims of nutraceuticals. Global Markets and trends. Potential health benefits of major nutraceuticals- omega-3, lycopene, flavonoids, isoflavonoids, prebiotics, probiotics, postbiotics, glucosamine and phytosterols. Metabolism, bioavailability and pharmacokinetics of nutraceuticals. Impact of thermal and non thermal processing on the bioactivity of nutraceuticals and functional ingredients in foods. Role of nutraceuticals in angiogenesis, cardiovascular diseases, obesity, diabetes, cholesterol management, eye, bone and mental health. Nutraceuticals and functional foods- therapeutic use, safety and toxicity. Nutraceuticals – Quality, stability and shelf life. Analytical techniques for estimation of nutraceuticals**.** Regulatory and legal aspects of functional foods. Current research in functional foods.

**N Diet. 308/ FND 308 Food Service Management 1+2 Sem. II**

Food service institutions-historical development and types. Styles of food services. Management, organization and administration of a food service establishment. Principles, functions and tools of management Organization of kitchen, storage areas, service area and layout designs. Equipment-classification, selection, purchase, operation, care and maintenance. Food purchasing, receiving, storage, menu planning, food production and service. Financial management-cost concepts, food cost control, pricing, book-keeping and accounting. Personnel management- policies, recruitment, selection, facilities, benefits, trainings and development. Sanitation, hygiene and safety in food service establishment. Laws governing food service establishments. Legal and current issues.

**Practical** : Standardization of recipes of snacks and main course dishes, portion size and costing. Compilation of standardized recipes. Preparation of various types of menu cards. Different types of table settings. Tray service of tea and snacks for 25 persons. Running a canteen for one day. Serving high tea to 20 persons and a meal to 10 persons. Maintenance of accounts and record keeping. Visit to different food service institutions.

**N Diet. 309 / FND 309 Drug Nutrient Interaction 2+0 Sem. II**

Drug interactions- basic concepts. Types and mechanism of various drugs and their interaction with nutrients. Bio pharmaceutics of orally ingested drugs. Relationship of drug therapy with intake, absorption and utilization of nutrients. Monitoring nutritional status in drug regimens. Antibiotic abuse and drug resistance. Drug induced malnutrition. Antibiotic abuse and drug resistance. Absorption of nutrients commonly affected by drugs and alcohol. Drug related gastrointestinal disorders. Obesity and appetite suppressant drugs. Drug induced metabolic alterations in patients receiving parenteral and enteral nutrition. Herbal and dietary supplements and their interaction with drugs. Dietary counselling to prevent food drug interactions and drug abuse. Computer applications in management of nutrient drug interaction. Drug nutrient interaction and Joint Commission for Health Care Organizations.

**N Diet. 310 / FND 310 Food Toxicology 2+0 Sem. II**

Introduction and significance of food toxicology. Types, causative factors, signs, symptoms and preventive measures of food poisoning. Natural food toxins. Anti-nutritional factors, fungal and seafood toxins, goitrogens and carcinogens - their harmful effects and methods of removal. Concept of food borne microbial infections and intoxication. Contamination- sources, effect on health, preventive measures and methods of inactivation/ destruction of micro-organisms. Chemical toxins - pesticides, metallic and radioactive materials, residual effects, preventive measures and methods of removal. Food packaging material and potential contaminants. Hazards of packaging material, contamination during storage and transportation.

**N Diet. 311/ FND 311 Meat and Meat Products: Preparation and Utilization 2+1 Sem. II**

Development of meat industry. Structure, composition, nutritive value, postmortem changes and eating quality of meat. Principles of various preservation techniques- chilling, freezing, curing, smoking, thermal processing, canning and irradiation. Meat cutting and packaging. Microbial and other deteriorative changes in meat and their identification. Standards and quality control measures adopted for meat and meat products in India - Meat Food Products Order(MFPO) and FSSA. Fraudulent substitution of meat and its recognition. Organic meat. Value added meat products and by product utilization. Effect of various cooking methods on the nutritive value of different meat products.

**Practical** : Evaluation of quality and grading of eggs. Preparation of various egg products. Market study related to meat and meat products. Post-mortem changes in poultry and meat. Evaluation of meat quality. Chilling a

**N Diet. 312 / FND 312 Food Analysis 3+1 Sem. II**

Food analysis- Introduction, definition, reasons and official methods . Rules and regulation for food analysis and its importance in quality control. Sampling techniques, terms and calculations used in preparation of various standard solutions. Principles, techniques and applications of colorimeter and spectrophotometer. Analysis of carbohydrates- introduction, methods of analysis, sample preparation,

extraction of monosaccharides, oligosaccharides, polysaccharides, starch, crude fiber and dietary fiber. Importance and analytical methods of moisture content – direct, indirect, evaporation, chemical, distillation and instrumental. Importance of protein analysis and analytical techniques- Kjeldahl, dumas, biuret, Lowry, dye binding, turbid and UV visible spectroscopy methods. Chromatography- basic principles, types and its applications. Analysis of fats- by solvent, non solvent and instrumental methods. Basic principles and analysis of antinutritional factors- tannins, phytates, oxalates. Importance and analysis of ash - dry , wet and low plasma temperature ashing. Analysis of different minerals by gravimetric and titration methods. Introduction and applications of Atomic Absorption Spectroscopy (AAS), Atomic Emission Spectroscopy (AES), pH meter, electrophoresis , High Performance Liquid Chromatography (HPLC) and Thin Layer Chromatography(TLC). Introduction to animal assay.

**Practical** : Introduction to glassware used in laboratory, preparation of samples and preparation of solutions and buffers. Proximate analysis- moisture, ash, crude fat, crude fibre, crude protein and carbohydrates. Demonstration of kelplus, fibraplus, socsplus for estimation of protein, fibre and fat. Estimation of reducing and non-reducing sugars in fruits. Estimation of starch content of cereals. Determination of iodine value and saponification number of fats.

**N Diet. 313/ FND 313 Fundamentals of Bakery and Confectionary 2+2 Sem. II**

Introduction to baking science. Terms and techniques used in bakery. Basic materials used in bakery and confectionery- their selection, properties and functions. Use of different bakery equipments. Role of gluten and starch in bakery products. Rheological properties of doughs and batters. Emulsifiers used in bakery. Biscuits and cookies- types, ingredients required and their role in biscuits and cookies preparation. Cakes- types of cakes, ingredients required and their role in cake preparation. Balancing a cake formula, characteristics of good cake -external and internal characteristics, faults and remedies in cakes preparation. Gelling, whipping agents and related products used in bakery and confectionery. Bread – ingredients required, steps involved and different methods of bread preparation. Characteristics of good bread -external and internal characteristics, bread defects and preventive measures. Icing – Types, ingredients used and their role in icing.

**Practical** : Balancing the formula for bakery products. Demonstration on standard method of making different types of biscuits- salty, coconut, fruit biscuits and cookies. Demonstration on standard method of making different types of cakes- plain cake, sponge cake, chocolate cake, pineapple upside down cake, walnut cake, fruit / plum cake, carrot cake and pastries. Icings and cake decorations. Preparation of supplemented and therapeutic bakery products - cakes, biscuits, cookies, breads and desserts.

**N Diet. 401/ FND 401 In-plant Training 0+16 Sem. I**

Hospitals/Nutraceutical /testing labs-Acquaintance with the working of dietary departments in hospitals. To record the clinical, nutritional and biochemical profile of the patients and modification of diets accordingly. Prescription of therapeutic diets

or

Acquaintance with the working in Nutraceutical /testing labs . To get training in various methods of assessing nutrient content of food stuffs and development of health foods.

**N Diet. 402/ FND 402 Report writing and presentation 0+4 Sem. I**

Case studies of patients suffering from different diseases. Development of entrepreneurial and managerial skills. Preparation of project proposal for establishing diet counselling cell including resource mobilisation, finance, raw material, site and manpower. Report writing and presentation.

or

Development of entrepreneurial and managerial skills. Preparation of project proposal for development of health foods including resource mobilisation, finance, raw material, site and manpower. Report writing and presentation.

**N Diet. 403/ FND 403 Seminar 1+0 Sem. II**

**N Diet. 404 / FND 404 Experiential Learning -I Diet and Nutrition Counseling 0+8 Sem. II**

Self assessment of role as a dietitian – pre-test on role, summary of competencies, preparation of self confidence checklist and post test on self role. Preparation of SOAP notes based on case studies and group discussion. Preparation of overweight and underweight fact list handout and development of counseling guidelines for weight loss and weight gain. Weight loss counseling– use of role play technique and workshop for patients at obesity clinic. Visit to hospitals with therapeutic kitchen setup. Diabetic diet counseling at diet and nutrition counseling centre, diabetic clinics, diabetic diet exhibition in collaboration with hospitals for the benefit of public, development of dietary fat facts list, cholesterol facts list, sodium facts list, Development of dietary counseling tips for different cardiovascular disorder and counseling; cardiac patients using role play technique, presentation in specialty hospital (CVD for patients as well as attendants). Diet exhibition on cardiovascular disorders in a specialty hospital / general hospital, preparation of handouts on ulcer facts list, high fibre facts list, low residue facts list, low lactose facts list, counseling for patients suffering from diarrhoea, constipation, colitis, diverticulosis and ulcer. Preparation of SOAP notes and gall bladder facts list handout and counseling a patient of gall stones. Preparation of liver disease facts list handout, collection of case history of patient suffering from hepatitis, cirrhosis of liver and alcoholics. Preparation of kidney disease facts list handout and development of counseling tips for kidney disorders, dietary counseling in a specialty hospital / diet and nutrition counseling centre for kidney disorder and diet exhibition for kidney disorder. Preparation of cancer facts list handout, Preparation of list of parenteral and enteral products available in the market for use during counseling.

**N Diet. 405/ FND 405 Experiential Learning -II Diet and Nutrition Counseling 0+12 Sem. II**

Planning normal and therapeutic diets for patients suffering from different diseases Counseling the patient and conducting group discussion. Role play exercises for counseling. Supervised counseling of patients/clients Preparation of list of parenteral and enteral products available in the market for use during counseling. Counseling to the community in relation to physical fitness and health. Organizing health camps and campaigns to create awareness regarding major public health problems. Setting up a unit for nutrition counseling.

# HUMAN DEVELOPMENT AND FAMILY STUDIES

## PROGRAMMES

**M.Sc.**

**Ph.D**

**Certificate Course in Early Childhood Care and Education (1 year)**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of Specialization | Human Development, Family Studies |
| Required Courses | HDFS-501, HDFS-502, HDFS-503, HDFS-504 |
| Supporting courses | Stat.-502 and Ext.-504 or other courses from subject matterfields(other minor) relating to area of special interest and research problem. |
| Minor fields | Extension Education and Communication Management, Food and Nutrition, Sociology or any other as approved by the Dean Postgraduate Studies. |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency courses for students with and approved elective other than Human Development and Family Studies | As recommended by the Student's Advisory Committee by the Dean, Postgraduate Studies |

### Ph.D

| | |
|---|---|
| Field of Specialization | Human Development, Family Studies |
| Required Courses | HDFS-601, HDFS-602, HDFS-603 |
| Supporting courses | A student can opt any course related to the topic of research offered by other other faculties of Agriculture University or SWAYAM portal or online courses up to a maximum of 5 credits. |
| Minor fields | Extension Education, Extension Education and Communication Management, Sociology or any other as approved by the Dean Postgraduate Studies. |
| Supporting Courses | A student can opt any course related to the topic of research offered by other faculties of agriculture university or SWAYAM portal or other online courses uptoa maximum of 5 credits |
| Deficiency courses | As recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**HDFS 101 Fundamentals of Human Development** **2+0 Sem. I**

Human development as a field of study. History of study of human development, scope and importance of study of human development from a life-span perspective. Relationship of the discipline of human development with other disciplines of study. Latest issues in human development. Growth and development-definition, difference between growth and development, determinants and principles of human growth and development. Genetic basis and concepts associated with human life, stages of human development, domains of human development and its characteristics. Theories of human development- naturalism, environmentalism, maturational, need, ecological, ethological, cognitive, social, psychoanalytical and moral. Definition of ethics and research, ethical principles and concerns in research with human subjects. Research designs and methods of data collection- their merits and demerits.

**HDFS 106 Human Values** **1+0 Sem. I, II**

Universal human aspirations- happiness and prosperity, attachment and detachment. Human values and ethics, concept ,definition, significance and sources. Goal, mission, vision, principles and philosophy of life. Fundamental value-right conduct, peace, truth, love, non- violence and selfless service. Ethics- professional, environmental and ICT. Case study of ethical lives. Sensitization/sensitivity towards others particularly senior citizens developmentally challenged and gender mainstreaming. Spirituality-body, mind and soul, positive spirit and attitude, scientific temper. Team work and volunteering. Rights and responsibilities. Road safety, human relations and value conflict. Sensitization against drug abuse and other social evils. Emotional, social and spiritual quotient/intelligence. SWOT analysis-self-exploration, self-awareness, self-satisfaction, decision making, motivation and success. Management of stress and anger.

**HDFS 102 Childhood and Adolescence** **2+1 Sem. II**

Stages of prenatal development. Issues and scientific concepts associated with conception and pregnancy. Pre-natal care- alternative methods of conception. Importance of prenatal diagnostic techniques. Birth process and types of birth. Postnatal care of mother and child. Characteristics of the new born. Causes and care of premature baby. Neonatal reflexes. Breast feeding, weaning and immunization. Infancy- physical, motor, social, emotional, cognitive and language developmental characteristics. Early Childhood- physical, motor, social, emotional, cognitive and language developmental characteristics. Early stimulation- importance and approaches. Middle childhood- physical, motor, social, emotional, cognitive and language developmental characteristics. Adolescence- physical, motor, social, emotional, cognitive and language developmental characteristics. Puberty. Developmental tasks of adolescence. Factors affecting growth and development during childhood and adolescence.Recent issues of childhood and adolescence.

**Practical:** Demonstration of techniques of feeding, bathing and dressing of new borns and infants. Monitoring growth and development of infants and toddlers. Case studies of individuals in different stages of development- Infancy, early childhood, school age and adolescence. Critical analysis of case study reports. Preparation of resource files.

**HDFS 103 Adulthood and Aging** **2+0 Sem. II**

Concept of adulthood and aging. Characteristics of early adulthood. Physical, social, emotional and mental changes during early adulthood. The family system at the early adulthood stage. Characteristics of middle adulthood years. Understanding midlife crisis or transitions. Physical, social, mental, developmental changes and issues at midlife. Family dynamics during middle-age years. Characteristics of late adulthood years. Developmental tasks of late adulthood. Physical, social, emotional and mental changes during late adulthood. Support system for the ageing family stage, living arrangements and institutionalization. Adjusting to occupational transitions, retirement and leisure. Demographics of ageing.

Developmental changes preceding death. Psychological reactions to bereavement and grief. Influence of religiosity and spiritual support on subjective well being during late adulthood. Status of geriatric care in India. Management approaches for better quality of life during old age. Recent issues of adulthood and old age.

**HDFS 201 Marriage and Family Dynamics** **2+1** **Sem. I**

Marriage- definition, functions, types of marriage in India, rituals and ceremonies of marriage in different religions of India. Readiness for marriage– definition, importance, areas of readiness and identifying characteristics of readiness for marriage. Mate selection- meaning, methods, ways of mate selection in tribal India. Factors responsible for wrong mate selection. Engagement and its importance. Marital roles- definition, importance and determinants. Marriage as status and role transition. Gender roles - concept, changing gender roles and factors for change. Role conflict. Marital adjustment- definition, areas and factors. Types ofmarital relations and adjustments, marital adjustment over the family life cycle. Obstacles in marital adjustment, improving marital adjustment and techniques of resolving differences. Marital dissolution- definition, types (Voluntary and Involuntary) and factors responsible for increase in the rate of legal marital dissolution. Factors responsible for refraining from divorce after marriage failure. Separation distress and factors affecting it. No-fault divorce, consequences of divorce, children's response to divorce, children as weapon against divorce and adjustment to divorce. Family- definition, functions and types of family. Family value system in India. Pattern of changes in family structure and relationships in India, familial (education and employment of women) and extra familial factors (technology, peer group, society) responsible for the changes and consequences of these changes on the family life and society. Family life cycle- definition, importance of studying family life cycle, developmental tasks and stages of family life cycle. Typical and alternative forms of families- characteristics of single parent families, female headed families, childless families, adoptive families and dual earner families. Reasons behind alternative form of family and its merits and demerits.Alternatives to marriage- singlehood, heterosexual cohabitation/ consensual union, homosexual union, reasons behind it and its merits and demerits. Family stress – definition, causes, variables affecting family's response to stress and stress coping strategies. Family crises- definition, when does stress becomes a crisis, what happens in a crisis? Stages of a crisis, characteristics of crisis events, effects of crises, factors which affectmeeting the crises, adjustment to crises, general things to do in times of crises. Laws and acts regarding marriage, adoption, divorce and inheritance in India. Counselling (premarital, marital and family) - objectives, importance, areas of counselling, types, process and effects.

**Practical :** Study on motives of marriage, selection of partner; visit to marriage bureau and family counselling center. Comparative study on nuclear and joint families, atypical families and alternative forms of families. Marital roles and adjustments, family crisis and coping; Roles across family life cycle.

**HDFS 202 Developmental Challenges in Children** **2+1** **Sem. II**

Special needs and special education- definitions, terminology, history, current trends and issues. Labelling- definition and its effects. Mainstreaming- definition, models, problems in implementing and effects. Mental retardation-definition, classification, prevalence, causes, identification & measurement psycho-social characteristics, educational considerations and management. Learning disabilities- definition, classification, prevalence, causes, identification & measurement of psycho-social characteristics, educational considerations and management. Emotional disorders- definition, classification, prevalence, causes, identification, psycho-social characteristics, educational considerations and management. Autism- definition, prevalence, causes, identification, psycho-social characteristics, educational considerations and management. Mechanism of Speech production. Speech and Language disorders- definition, classification, prevalence, causes, identification, psycho-social characteristics, educational considerations and management. Hearing impairment- definition, anatomy and physiology of ear, classification, prevalence, causes, identification & measurement of psycho-social characteristics, educational considerations and management. Visual impairment -definition, classification, prevalence, anatomy and physiology of eye, causes, identification & measurement of psycho-social characteristics, educational considerations and management. Physical impairment- definition, classification, prevalence, causes, identification, psycho-social characteristics, educational considerations and management. Multiple disorders. Giftedness - definition, prevalence, origin, screening and identification, psycho-social

characteristics, educational considerations and management of giftedness. Rights and provisions for children with special needs in India. Legislation and litigation. Intervention- concept, need and importance, methods, steps, process. Role of professionals in intervention.

**Practical:** Observational visits to institutes for children with special needs. Identification of children with special needs in local community. Selection of a differently abled child and preparation of case study. Planning and organizing education programmes for families of children with special needs. Developing educational material and conducting need based interventions. Presentation of case study reports.

**HDFS 301 Family Counselling and Child Welfare 2+1 Sem. I**

Concept, nature, scope, principles and need of family counselling. Thrust areas of family counselling- educational, vocational, social, personal, premarital and marital. Problems in family counselling and methods of handling. Approaches to evaluate family counselling, Qualities of an effective counselor. Situational analysis of children, women, youth, elderly, differently abled and socially backward classes in India and abroad. Issues and challenges. Determining factors for the present status its impact on the family and society. Child welfare- definition and need. Constitutional provisions, laws, schemes, projects and policies for children and other welfare activities of child welfare. Women welfare- definition and need. Constitutional provisions, laws, schemes, projects, policies and other welfare activities. Youth welfare- definition and need. Constitutional provisions, laws, schemes, projects, policies and activities to combat drug addiction. Elderly welfare- definition and need. Constitutional provisions, laws, schemes, projects and policies for elderly. Differently abled welfare - definition, need, constitutional provisions, laws, schemes, projects and policies for differently abled. Welfare of socially backward- definition, need, constitutional provisions, laws, schemes, projects and policies. National and international organizations and agencies working for the welfare of children, women, youth, elderly and differently abled: UNICEF, WHO, CARE, DWACRA, NIPCCD, CIF, CRY, Helpage India, etc.

**Practical** : Visits to organisations offering counselling to families. Studying the areas of family counselling. Visits to various government and non-government organisations working for the welfare of the children women, youth, elderly, socially backward. Presentation of reports.

**HDFS 302 Educational Psychology and Early Childhood Education 2+1 Sem. II**

Educational psychology- Meaning, nature, scope and importance of educational psychology, history of its evolution, abroad and in India, recent trends and challenges in educational psychology concept of learning- definition, essential features, types of learning, laws of learning, principles of learning, learning traits- sensation, perception, imagination, attention and memory, remembering and forgetting, intelligence-reasoning and thinking, temperament, problem solving, information processing learning environment- reinforcement- definition, types of reinforcements, schedules of reinforcement, importance of reinforcement in learning, punishment- meaning, functions, types, essentials of good punishment, effect of punishment on learning, motivation- definition, types, modes of motivation (contingency contract, token economy) relationship of motivation with learning and performance discipline- meaning, social attitudes towards it, need for discipline, wholesome and unwholesome functions of it, essentials in discipline, techniques of discipline, factors influencing choice of disciplinary techniques, evaluation of disciplinary techniques, theories for classroom teaching and its applicability – learning theories of Jerome Bruner, Robert Gagne, Jean Piaget, Erik Erikson, Lev Vygotsky, Lawrence Kohlberg performance evaluation. Meaning, characteristics and significance of early childhood years. Programme planning in ECE- Steps and types of programme planning, activities to promote all round development of preschool children- cognitive, language, socio-emotional and motor development, role, qualities and responsibilities of an early childhood personnel.

**Practical** : Planning, implementing and analyzing effect of reinforcement, motivation and discipline on learning. Observation and recording of activities in ECE center. Developing and conducting activities to promote all round development –Gross and fine motor skills, cognitive skills, language skills, creativity and socio emotional skills. Preparation of suitable teaching learning material used for preschool children.

**HDFS 401 Seminar** **1+0** **Sem. I**

**HDFS 402 Experiential Learning-I Early Childhood Care and Education** **0+8** **Sem. I**

**Practical** : Conducting tests for Neonatal assessment – APGAR. Neonatal Behavioural Assessment Scale for infants and toddlers, developmental assessment though anthropometry, Developmental Screening Test, Bayley's Scale of Infant Development, Vineland Social Maturity Scale. Screening and assessment of preschool and primary school children- Stanford Binet Intelligence Scale, Wechsler Scale of Intelligence for preschool and primary School Children, Thematic Apperception Test, Children's Apperception Test, Raven's Coloured Progressive Matrices; Ecological assessment of Preschool and primary school children- Home Observation Measurement of the Environment (HOME) . Developing case studies. Assessment of readiness skills of pre-primary school children- auditory perception, visual perception, writing, reading, arithmetic and discriminatory skills. Presentation of reports. Conducting educational programmes for parents on the developmental status of children. Identifying the intervention needs of developmentally delayed children. Planning and implementation of intervention programme. Conducting Post intervention evaluation. Presentation of reports.

**HDFS 403 Experiential Learning - II Early Childhood Care and Education** **0+12** **Sem. I**

**Practical** : Developing concept and understanding the need, characteristics, functions and types of project planning. Need assessment for early childhood care and education services. Evaluative analysis of the existing early childhood care and education services. Developing skills in infrastructure planning and preparing layout plans for early childhood care and education centers in different settings. Budget Planning. Long-term and short-term curriculum planning. Framing administrative and staff recruitment policies. Record keeping. Diet planning. Hands on experience in operationalization of the early childhood care and education programmes - planning activities for physical, cognitive, language, socio-emotional and moral development. Market survey of available material. Analysis of the existing status of the available material. Designing and development of age appropriate learning material for different concepts. Arranging and equipping the classroom for optimising safety and learning. Conducting activities for furthering all aspects of development. Observing transition of activities during the day. Working with children, parents and their families. Planning and execution of parent education programmes by using different techniques of parent education - lectures, demonstrations, role play, mass communication, panel discussions etc. Learning to address emergencies.

**HDFS Rural Awareness Work Experience** **0+10** **Sem. II**

**HDFS 412 Internship-I Entrepreneurial Placement /In plant Training** **0+8** **Sem. II**

**Practical** : Placement with an entrepreneur for studying the organizational structure and activities of the institution. Planning and execution of programme for the beneficiaries. Evaluation of the efficacy of the programme. Development of entrepreneurial and managerial skills.

**HDFS 413 Internship-II Project Report and Presentation** **0+2** **Sem. II**

**Practical** : Preparation of project proposal for establishment of early childhood care and education centres including objectives, infrastructure, budgeting working policies, staffing, programme planning, and evaluation. Report writing and presentation.

## Postgraduate Courses

**HDFS-501 Theories of Human Development** **3+0** **Sem. I**

**Unit I** Psycho-dynamic theories

Meaning, types and functions of developmental theories. Theoretical perspectives and approaches Psycho-dynamic theories- Psycho-analytic Theory of Sigmund Freud – life history of Sigmund Freud, key concepts of psycho analytic Theory, laws of psychological energy, three components of personality and their operational principles. Structural model of personality. Psycho-sexual stages and their impact on process of personality development. Contribution and criticism of Freudian Theory. Neo-Freudians. Psycho-social Theory of Erik Erikson – concept of development and basis of development, psycho-social stages of life.

**Unit II** Maturation and cognitive theories

Maturation and cognitive theories Maturational and biological approach- Arnold Gessell's Theory of maturation. Cognitive Development Theory of Jean Piaget – concepts, cognitive mechanism, cognitive structure, different stages of cognitive development, thought process and implications of the Theory. Piaget's contribution to field of education. Neo-Piagetians- Fischer, Robert Case, Robert Sieglar and Bruner. Socio-cultural Theory of Lev Vygotsky. Information processing theories.

**Unit III** Behavioural and ecological systems theories

Behavioural and ecological systems theories Behavioural approach of Watson. Stimulus Response Theory by Sears, Skinner and Pavlov. Social- Learning and Social Cognition Theory by Albert Bandura and its application in human development. Ecological Systems Theory of Urie Bronfrenbrenner - concepts, systems and implications in understanding human development. Contribution of ecological systems Theory in guiding families and teachers. Language development Theory of Naom Chomsky.

**Unit IV** Attachment, self and moral theories

Attachment, self and moral theories Attachment theories by John Bowlby and Ainsworth. Maslow's Need Hierarchy model. Self Theories- Models of Morris Rosenberg and Cooppersmith. Moral development theories of Lawrence Kohlberg and Jean Piaget. Comparative analysis of theories and their application. Integrated approach to Theory building

**HDFS-502 Dynamics of Human Development 3+0 Sem. I**

**Unit I** Nature vs. Nurture

Human development – basic concepts and issues. Genetic foundation, genetic code, chromosomal abnormalities. Role of epigenesis and canalization in growth and development. Interface between heredity and environment. Genetic research and its influence on child's development. Current research findings on pre-natal development and neo-natal stages – developmental sequence, prenatal environmental influences, developmental threats and DNA methylation.

**Unit II** Cognitive development

Brain development- key concepts and process of development. Models of intelligence. Cognitive development during early years - perceptual capacities, attention, memory, imitation, early learning, conditioning and assessment. Role of early deprivation and enrichment in cognition. Information processing. Social cognition, emotional intelligence, metacognition and self regulation and their contribution to human mind and behavior. Gardner's Model of Multiple Intelligence.

**Unit III** Psycho-social Issues

Language development and its components - pre-linguistic development, phonology, semantics and bilingualism. Socialization practices and influencing factors. Cultural influence on child outcomes. Exposure to media and technology and role of parents and institutions. Impact of socioemotional deprivation on different stages of development. Vulnerability and resilience, risk and protective factors. Personality changes and self perceptions through different stages of development. Integrated view of human development.

**Unit IV** Current and classic research trends in human development

Seminal work of Sigmund Freud, Erikson, Piaget, Uri Bronfenbrenner and Margaret Mead. Design and field work of "Six cultures project". Current research trends in physical, intellectual, psychosocial and moral development of children from birth to adolescence.

**HDFS-503 Methods and Techniques of Assessment in Human Development 2+1 Sem. I**

**Unit I** Developmental assessment, methods and techniques

Assessment –Concept, functions, characteristics, steps and rationale of assessment. History of tests and measurements. Different methods of child study /developmental assessment. Techniques of measurement and their significance in measuring different aspects of human development. Role of assessment in intervention.

**Unit II** Types of measures & methods

Scientific methods-definition, importance, goals and steps. Essential criteria of Scientific methods -reliability, validity control, item analysis. Use of objective measures and methods.

Types of tests – individual and group tests. Projective techniques. Psychometrics, Sociometry. Types of scales –nominal, ordinal, interval & ratio scale

**Unit III** Development of tests / scales

Developmental Assessment from birth to early childhood. Tests for infants and children. APGAR scoring of new borns. Physical growth assessment. Anthropometric evaluation of nutritional status. Measurement of intelligence. Assessment of personality, aptitude, attitude and environment. Development of test / scale, steps, guidelines and standardization procedure – various methods of calculation of validity and reliability. Variables- extraneous, confounding, researcher variables & participant variables affecting internal validity. Threats to internal validity.

**Unit IV** Ethical issues and barriers

Ethical issues and barriers Ethical issues in the assessment of human development. Special consideration in assessing young children. Ethical issues and barriers in assessment of infants and young children. Assessment of children with special needs. Interpretation and use of assessment information. Trends and challenges in assessment of human behavior.

**Practical** : Visit to neonatal unit to observe the neonates and to observe their assessment of APGAR score by pediatricians. Physical Growth assessment and nutritional status of children of different age groups. Review of available developmental screening and diagnostic tests for infants, toddlers and pre-school children. Review of available screening and diagnostic tests for school age children and adolescents. Developmental assessment of infants by using Bayley's Scale of Infant Development (BSID) Interpretation of results and report writing. Administration of psychological tests for measuring cognitive abilities and intelligence. Administration of psychological tests for assessment of socio-emotional development of children and adolescents. Administration of psychological tests for personality assessment. Administration of psychological tests for assessment of language development of children. Assessment of home environment using HOME (Home Observation and Measurement of Environment) inventory for different age groups of children / Indian Home Inventory / Family Environment Scale. Interpretation of results and report writing on home environment Development of scale or check lists on selected areas of development. Standardization of the developed test, scoring and interpretation of results.

**HDFS-504 Innovative Programmes in Early Childhood Development and Education 2+1 Sem. II**

**Unit I** Innovative programmes in early childhood development and education

Need and scope for innovative programmes for early childhood development and education (ECDE). Innovative pedagogical approaches in early childhood development and education. Developmental patterns of children in early years. Current innovative programmes at State, National and International level. Innovative learning settings in classrooms of early child development and education centres. Usage of virtual and digital classrooms in Child Development and Education Centres.

**Unit II** Innovative programmes for child development

Methods and principles of designing, execution, monitoring and evaluation of programmes and activities in early childhood care and education centres. Innovative programmes for fostering physical, motor, cognitive, speech and language, creativity, socio- emotional and moral development of children.

**Unit III** Stimulatory learning environment

Stimulatory learning environments at home and early childhood child care and education centres and at centres for children with special needs. Current and conventional practices of stimulatory learning. Innovative ideas for planning and execution of customized programmes/ activities for gifted children and differently able children.

**Unit IV** Social support network systems

Innovative programmes for involving families in early childhood development and education centres. Challenges of family involvement. Development of social support network systems for inclusion of differently able children

**Practical** : Visits to observe early childhood care, education and development centers using varied pedagogical approaches in urban / rural settings and study their programme and activities. Creche / day care centre and Urban Nursery school ii. Visit to Aanganwadi centre and rural nursery school. Critical analysis and report presentation. Class room discussions on different types of virtual and digital classrooms. Designing innovative activities for young children - Physical and motor development . Designing innovative activities for young children - Cognitive and language development . Designing innovative activities for young children - Social, emotional and moral development. Execution of designed innovative activities. Evaluation of the designed innovative activities as per their effectiveness and implementation potential. Conducting survey to assess parental needs on knowledge of innovative activities. Designing need based parent education programmes Organization of parent education programme. Conducting need assessment study to find out the training needs of ECCE staff. Planning of workshop/training for ECCE personnel. Conducting workshop/training for ECCE personnel

**HDFS-505 Gender Issues In Human Development and Relationships** **2+1** **Sem. II**

**Unit I** Gender perspectives and theories

Concept of gender- biological and socio-cultural connotations. Historical erspectives. Gender differences in human development. Gender theories- Gender Orientation Theory of Sandra Bem. Gender Schema Theory, Theory of Ego Development and Gender. Gender StratificationTheory by lumberg. Gender Identity Formation Theory.

**Unit II** Gender discrimination, gap and parity

Gender equality and development. Gender inequalities in human development– dimensions, causes and consequences. Gender discrimination indicators- global gender gaps. Gender Development Index, Global Gender Gap Index and Gender Parity Index. Demographic challenges to family ecology- gender role socialization.

**Unit III** Gender violence and empowerment

Gender violence- dowry harassment and deaths, suicides, prostitution, sexual harassment and exploitation and prevention. Family violence, amniocentesis, female feticide, infanticide, eve teasing. Gender empowerment strategies- working towards family solidarity and social well-being. Gender main streaming- concept, policy of United Nations, objectives, requirements and principles. Empowering lives of women by controlling – patriarchy system, women's sexuality, fertility, labour, lack of visibility. Gender budgeting.

**Unit IV** Changing trends in status of women Status of women in India. Various plans and policies designed for achieving gender equality. Changing trends in gender role orientation- early civilization, pre-independence, post independent India, contemporary times, socio economic impact on the family and society, cultural impact on the family. Gender role portrayal in mass media. Gender stereotyping in schools. Gender issues at workplace.

**Practical** : Gender analysis of mass media: Print media and E-media. Study of adopted socialization practices for children of both genders. Report writing. Case studies of three generations on dynamics of gender orientation. Report presentation and discussion. Case studies of three generations on dynamics of Gender roles and responsibilities. Report presentation and discussion. Views of adolescents on their gender role orientation- designing questions. Survey through questionnaire. Report presentation and discussion. Case studies on changing trends of roles and responsibilities of women and men. Visits to women welfare Govt. organizations / agencies / NGOs.

**HDFS-506 Adult Development** **2+0** **Sem. I**

**Unit I** Theoretical and ecological perspectives of adult development

Adulthood- transition to adulthood, stages of adulthood. Psychosocial theories of aging - Erikson's

Psychosocial Theory, Identity Process Theory, Activity Theory, Socio-emotional Selectivity Theory. Theoretical perspectives in adult development - Bio-psychosocial perspective, Ecological perspective, Life Course perspective. Klaus Riegel's Dimensions of Development Theory. Four principles of adult development and aging.

**Unit II** Models and stereotypes in adulthood

Models of development- biological model of aging, psychological models of adulthood development, socio-cultural models of development, nature and nurture in adulthood- individual and environment interactions. Reciprocity in development. Themes and issues in adult development and aging. Ageism and stereotyping the elderly.

**Unit III** Developmental changes during adulthood

Developmental changes in adulthood – biological changes, cognitive changes, sensory changes, psychological and social interactional changes associated with aging. Aging and health. Factors affecting health. Lifestyle and health. Key concepts in health and prevention of chronic diseases, physical and neuro-cognitive disorders and others. Risk factors and preventive measures, supportive services.

**Unit IV** Adulthood Adjustment

Demographics of an aging population. Gender differences in aging. Menopause and its effects on women. Cessation of sexual prowess and its effect on men. Issues and adjustments related to occupation, self and family. Retirement, leisure and adjustment. Causes of morbidity and mortality across the life cycle. Human longevity - the influence of genetic and environmental factors. Death, dying and bereavement. Attitude towards death, grief and bereavement.

**HDFS-507 Management of Differently Abled 2+1 Sem. I**

**Unit I** Classification and statistics of differently abled

Concept and classification of differently abled individuals. Their current statistics. It's implications on the quality of life. Social, emotional, and economic aspects of exceptionality for both children and families. Multi disciplinary view of differently abled individuals.

**Unit II** Characteristics, etiology and issues of differently abled

Different abilities- mental deficiency, learning disabilities, visual impairment, hearing impairment, communication disorders, neurological disorders – definition, types, characteristics, etiology, prevalence in India for all above different abilities. Associated psychological and behavioural problems, educational provisions, management considerations and remedial programmes for different types of special needs.

**Unit III** Educational & vocational interventions for differently abled

Physical impairment or loco-motor disabilities (Orthopedic and neurological impairment)- definition, classification, assessment and etiology. Psychological and behavioural characteristics of physically challenged children. Educational and vocational interventions. Remedial programmes for physically challenged. Psycho-social disturbances and social maladjustment – definition, classification, types, characteristics and etiology of emotionally disturbed and socially maladjusted. Management considerations and remedial programmes for psycho-socially disturbed and socially maladjusted. Gifted children - definition, types, characteristics, assessment and prevalence in India. Inclusive education and special programmes for the gifted.

**Unit IV** Government support services

Preventive measures. Assistive technologies for different developmental challenges. Inclusive education policies and programmes for differently abled persons. Government provisions, concessions, facilities, rights and legislations for differently abled. Community based rehabilitation. Rehabilitation Council of India. National and International agencies for differently abled individuals.

**Practical** : Case studies of differently abled persons- etiology, characteristics, assessment of their different abilities i) Mentally subnormal children ii) Visually impaired children iii) Hearing impaired children iv) Speech impaired children v) Orthopedically handicapped vi) Learning disabled children vii) Gifted children. Collaborative work with professionals in development of intervention packages for differently

abled children (for any one category). Conducting home based interventions. Conducting center based interventions at schools/ child clinics/ pediatric wards/ special schools and so on. Report writing and presentation. Collaborative work with professionals in development of intervention packages for differently abled children (for any second category). Conducting home based interventions Conducting center based interventions at schools/ clinics/ pediatric wards / special schools etc. Report writing and class presentation.

**HDFS-508 Adolescent Development and Challenges 2+1 Sem. I**

**Unit I** Theoretical perspectives of adolescents

Adolescence – definition, significance of the stage. Theoretical perspectives on adolescence – biological, psycho-analytical, psycho-social, social-cognitive and cultural. Physical and sexual development in adolescence - physical transition from child to adult, adolescent growth spurt, puberty causes and changes, psychological impact of puberty, early and late maturation and its psychological implications, adolescent sexuality, causes and correlates of physical development.

**Unit II** Cognitive and communication development during adolescence

Cognitive and intellectual development during adolescence- the formal-operational stage, hypothetico-deductive reasoning, thinking like a scientist, complexities of adolescent thoughts, information-processing view of adolescent cognitive development, gender differences in mental abilities. Language development during adolescence- later syntactic development, semantics and meta-linguistic awareness, development of communication skills, learning in school and vocational development.

**Unit III** Psycho-social and personality development

Psychosocial development during adolescence- emotional changes, problems, emotional regulation and stability, self-understanding. Role of family, peers, school in psychosocial 13 Gifted children - definition, types, characteristics, assessment, prevalence in India. Inclusive education and special programmes for the gifted. Preventive measures. Assistive technologies for different types of challenges. Inclusive education. Community based rehabilitation. 15 Government policies and provisions for differently abled. Concessions, facilities, rights and legislations. 16 Rehabilitation Council of India. National and International agencies for differently abled individuals, Work, career, heterosexual relationships in adolescence. Personality development Erikson's Theory, identity crisis, identity diffusion, identity foreclosure, identity moratorium, self-concept, gender-role stereotyping. Moral development during adolescence and value orientation. Environmental learning, interactional and cultural context in moral development.

**Unit IV** Different challenges of adolescence

Vocational preferences. Transition to adulthood- conflicts with special reference to contemporary socio – cultural changes. Challenges of adolescence- sexuality, aggression, delinquency, AIDS, substance abuse, alcoholism, personality disorders, depression, suicide, eating disorders, health problems, psychological problems, social problems- dating and relationships. Integration of self and psycho-sexual resolution. Resolving identity crisis- reorganization of social life relationship with peers and parents, heterosexual relationships.Risk and resilience during adolescence. Risk and protective factors. Challenges in adolescent's life in the 21st century. Challenges and opportunities for adolescent research. Programs and policies.

**Practical** : Case studies- interviewing early and late adolescents on issues, problems, pubertal changes, friendships, career aspirations, self and social awareness, mass media references.

Development of case study format ii) Conducting case study of early adolescent girl and early adolescent boy iii) Conducting case study of late adolescent girl and late adolescent boy . Report writing and presentation of case studies . Assessment of intellectual abilities of adolescents and class room discussion. Assessment of psycho-social development patterns of adolescents and class room discussion. Depiction of adolescents in mass media: Content analysis of media- i) Feature films ii) Television serials iii) Literature-magazines, newspapers, advertisements. Report writing and presentation Survey in rural / semi-urban/ urban communities on challenges faced by adolescents and their Parents. Survey in rural/ semi-urban/ urban communities on challenges faced by teachers of Adolescents Analysis of survey results for adolescent challenges and their need assessment. Planning intervention education

programmes for adolescents. Organising intervention education programmes for adolescents about their developmental changes, needs and coping up strategies.

**HDFS-509 Guidance And Counselling** **2+1** **Sem. I**

**Unit I** Areas and types of guidance & counselling

Areas and types of guidance & counselling Guidance and Counselling – Meaning, history, goals, levels and techniques. Areas of guidance and Counselling. Types of guidance and counseling services - educational, vocational, personal, marriage and family, leisure time. Assessment and diagnostics in counselling.

**Unit II** Contemporary trends and ethical issues

Counselling and therapy relationships. Counselling children - goals, child-counsellor relationships. History about counselling children. Contemporary issues. Play therapy. Integrated counselling for children. Guidance and counselling in schools and colleges. Group guidance. Couple, pre-marital, marriage and family counselling. Current trends in counselling, computerized therapy programs. Research trends in guidance and counseling in India and abroad.

**Unit III** Essentials of conducting guidance and counselling sessions

Competencies and role of guidance and counselling professionals. Modes and methods of counselling. Essentials of conducting guidance and counselling session. Understanding the process of guidance and counseling. Ethical issues in guidance and counselling. Knowledge and skills to handle assessment tools. Effective communication and documentation skills. Networking with allied professionals and institutions. Counselling with special concerns, Children with developmental challenges, ambivalent and oppositional type, crisis counselling, guidance in adolescence, counselling elderly.

**Unit IV** Approaches and theories of counselling

Approaches and theories of counselling: Affective Counselling Theory- concept, key principles. Humanistic approaches- Roger's Client centered approach, Gestalt approach. Psychoanalytic - Psychodynamic approaches by Sigmund Freud, Carl Jung, Alfred Adler and Melanie Klien. Skinner's Behaviouristic approach, Bandura's Behaviour Modification approach. Rational emotive behaviour therapy. Reality therapy. Beck's Cognitive –Behaviour approach.

**Practical** : Compiling research reviews on various aspects of guidance and counselling. Preparing a checklist to observe and analyze guidance and counselling centers – their organizational structure, objectives, types of services provided, available facilities, staff competencies and problems experienced by them etc. Survey of guidance and counselling centers by using prepared observation check list .Visit to observe and conduct interviews to get information about the counselling services provided by these institutions such as-Women welfare & child development . Family court Women cell etc., Preparation and presentation of report . Visit to observe career guidance centers. Feed back of the clients towards the services, financial management /budget, support of other professionals /agencies to different types of centers. Simulation exercises of guidance and counselling children and parents. .Content analysis of problems addressed by the leading counselling centers. Content analysis of prevailing psychosocial problems reported in print and electronic media. Identification of characteristics and skills of the counsellors by watching recorded videos on child and adolescent counselling. Understanding techniques used by counsellors by watching recorded videos on child and parent guidance, child counselling, adolescent counselling, couple counselling. Writing reports on films and videos related to the course and its presentation.

**HDFS-510 Interventions For Diffrerently Abled Children** **1+1** **Sem. II**

**Unit I** Significance and types of intervention services

Intervention services- concept, need and significance. Prevention of avoidable health problems. Early intervention –concept, need and significance. Therapies and services- types and contents. Family centred, Child focused intervention, supportive and structured intervention. Speech therapy, occupational therapy, play based intervention. Competencies and role of guidance and counselling professionals. Modes and methods of counselling. Essentials of conducting guidance and counselling session. Understanding

the process of guidance and counselling. Ethical issues in counselling. Knowledge and skills to handle assessment tools. Effective communication and documentation skills. Networking with allied professionals and institutions. Counselling special groups. Counselling children with developmental challenges. Counselling ambivalent, different & oppositional type children. Crisis counselling - death, financial, suicidal, academic failure, illness etc. Guidance for adolescence. Counselling elderly. Approaches and theories of counselling: Affective Counselling Theory- concept, key principles. Humanistic approaches- Roger's Client centred approach, Gestalt approach. Psychoanalytic -Psychodynamic approaches by Sigmund Freud, Carl Jung, Alfred Adler and Melanie Klien. Skinner's Behaviouristic approach, Bandura's Behaviour Modification approach. Rational emotive behaviour therapy. Reality therapy. Beck's Cognitive–Behaviour approach.

**Unit II** Intervention Strategies and Steps

Guidelines for intervention programmes for differently abled. Problems and strategies. Process and steps of intervention- identification, assessment and diagnosis of differently abled and at-risk children, planning and designing intervention, implementation and evaluation. Curriculum planning for differently abled children.

**Unit III** Development of intervention programme

Developing need based intervention programmes and strategies for different categories of developmentally challenged children and their parents. Understanding key elements for successful interventions- tailoring for individual needs, providing normality and integration, provision of optimal environment for developmental progress, environmental compatibility and remedial services.

**Unit IV** Executing intervention and multi disciplinary approach

Executing child and parent focused interventions and evaluating its effectiveness. Multi disciplinary approach-significance, strategies to include parents and community and overcoming barriers. Planning interventions for inclusion. Involving parents and community.

**Practical** : Identification of families having children with specific disability .Based on selected families, developing need assessment checklist of differently abled children and their families. Need assessment of differently abled children and their families, report presentation and enlisting the needs of family and differently abled child care & development. Designing and developing intervention modules/ programme based on needs of differently abled children and their families. Presentation of intervention modules/ programme, its evaluation and enhancement. Intervention programme : Material selection from department and market survey of required Material / toys / tools / books etc. Presentation of students' ideas for development of educational and development oriented material / tools for intervention, discussion on it and finalizing the intervention material and tools. 8 Understanding and experiencing purchase procedure for required material- Seeking permissions of the authorities for purchases, drawing advances (Money indent), submission of vouchers and entry of material in registers. Preparation and up gradation of intervention activities, material and tools. Evaluation of effectiveness of intervention programme in catering the identified needs of families and their differently abled children. Conducting parents / community workshops for publicity of benefits of need based intervention programmes for creating awareness and motivation in families for the welfare of differently abled children.

**HDFS-511 Family Ecology** **2+0** **Sem. I**

**Unit I** Family relationships

Family as a social system. Socialization within the family. Models of parenting. Parent child relationships- functional and dysfunctional dyads. Family cohesion, conflict and family disorganization –impact on parenting. Children as family agents. Children and marital life. Child abuse. Bidirectionality in parent child relations. Family interactions and delinquency. Improving family communication and interpersonal relations.

**Unit II** Family under transition

Family transitions. Change and continuity over life cycle. Needs and problems of families at different developmental stages. Impact of social change on family and changing family patterns in India. Religion and family. Family social class and ethnic variations in child rearing.

**Unit III** Family stressors and resilience

Family as an institution under stress. Family crisis. Poverty and children. Stressors and family relations - with special reference to family disruption, sickness, divorce, substance abuse and disability. Stress Process Model. Family's adaptation to stress. Family resilience and protective factors for promotion of family resilience. Family environment and social support as a source of risk and resilience for vulnerable children/youth. Intergenerational family dynamics in management of family conflicts and negative patterns.

**Unit IV** Impact of consumerism, emigration and multiculturalism on families

Impact of consumerism on rural and urban families. Impact of emigration and multiculturalism on families. Two culture children and their psycho-social dilemmas. Contemporary issues related to family

**HDFS-512 Family and Cultural Diversities** **2+0** **Sem. I**

**Unit I** Culture and family Culture

Culture-definition, components and characteristics of culture. Agents of cultural influences school, family, community and other social groups. Cultural factors and impact on families. Western versus Eastern family culture. Cultural diversities in India. Elements of India's diverse culture – religion, philosophy, cuisine, language, fine arts, dance, music.

**Unit II** Families in India and abroad

Families in India and abroad - communal, nuclear, joint, extended, polyamorous, polyandrous, polygynous, single parent families, unrelated families. Indian family culture-values and issues concerning families and its stability. Factors determining social status of families. Families in rural and tribal agrarian community – status of women, children, elderly and men in the families.

**Unit III** Cross-cultural variations in family functioning

Cross-cultural variations in different aspects of family functioning across different West and East countries/ cultures viz a viz – marriage, parenthood, relationships, care of elderly and status of women. Cross cultural variations in family functioning, roles and responsibilities, cohesion, interpersonal communication patterns, conflict resolution. Parenting across cultures – child rearing, socialization and socialization practices. Family crisis and adaptations across cultures. Unique family experiences across cultures, some classic examples like Kibbutz in Israel.

**Unit IV:** Diversities in family life and challenges

Diversities in family life – ethnic, linguistic, regional etc. Effect of urbanization, secularization, westernization, technological advancement, globalization and other such developments on families in general and agrarian in particular. Challenges before families across cultures. Legal provisions – emerging cultural trends. Research trends in cross-cultural family studies, methodological issues.

**HDFS-513 Family Therapy** **2+1** **Sem. I**

**Unit I** Family therapy - orientation and theoretical perspectives

Family Therapy – concept, need, significance, areas, scope, goals and application of marriage and family therapies. Evolution of family therapy. Early models and basic techniques of family therapy- group process and communications analysis. Theoretical developments in marital and family therapy. Approaches in family therapy - Social Learning approach, Psychoanalytic, Behavioural, Systems approach. Social Constructionism Theory. Attachment Theory.

**Unit II** Types of family therapy

Classic schools of family therapy- Bowenian Family Systems therapy, Strategic, Structured, Communication and Experiential therapies, Psychodynamic Therapy, Cognitive- Behaviour family therapy and integrated family therapy. Contemporary marital therapies. Family therapy in the 21st century and its application to multicultural, single parent and disorganized families, solution focused therapy, narrative therapy and integrative models. Application of family therapy in depression, substance abuse, schizophrenia and eating disorders.

**Unit III** Concerns for family therapy

Signs and symptoms of family in need of therapies- psychosomatic symptoms, psychiatric disorders, marital distress, alcoholism, drug dependence, juvenile offences, problems of adolescence, conduct problems, work and school phobias.

**Unit IV** Prospects of family therapy

Qualities of marriage and family therapists. Techniques of marriage and family therapy. Advances in clinical assessment, preventive and enrichment programmes. Future direction for marriage and family therapy- bridging research, Theory and practices.

**Practical** : Observational visits and screening families in need of therapy (in various settings) and preparation of format for it. -Visiting and screening of urban families in need of therapy. Visiting and screening of slum families in need of therapy . Visiting and screening of rural families in need of therapy. Report presentation and discussion . Case studies of different areas of marriage and family therapy (alcoholism, drug, dependence, juvenile offences, problems of adolescence). Preparation of format. Case study of alcoholic de –addiction. Case study of drug dependence and de –addiction. Case study of juvenile offences and rehabilitation. Case study of socio-emotional problems of adolescents. Report presentation and discussion. Case studies of different methods and techniques of marriage and family Therapy (one from each): Visit to marriage and family therapy centre Observation of sessions for knowing the methods and techniques used in marriage and family therapy ( actual). Observation of sessions for knowing the methods and techniques used in marriage and family therapy ( recorded ones). Report presentation and discussion.

**HDFS-591 Seminar** **1+0**

**HDFS-599 Master's Research** **0+30**

## Ph.D. courses

**HDFS-601 Advanced Human Development** **3+0** **Sem. II**

**Unit I** Human development – a science and a process

Human development – a science and a process Classical and contemporary theoretical orientation to human development. Relational developmental systems and developmental science. Developmental psychology to developmental science from deficit to diversity in development. Regulation of development and differentiation. Constructing general model for development – developmental behaviour genetics. Multilevel nature and analysis of developmental processes.

**Unit II** Developmental diversity and regularity

Concept of Consistency vs. change in development. Developmental diversity and regularity.Developmental diversity and consequences for Human Development. Dynamics of stability and variability in development – role of experience in development, Optimal Experience Theory. Human action perspective to developmental diversity and regularity. Abnormal behaviour vs. individual differences. Intentional personal development and personal controlover development.

**Unit III** Development through life span

Life span Theory in development, five levels of analysis – Life cause Theory, basic concepts,life transitions and historical change. Continuity vs. discontinuity in different developmentsacross stages of life. Cognitive and emotional development- development of children's thinking and emotions. Dynamic development of thinking, feeling and acting- infancy through adulthood. Emotional development and consciousness. Dynamic structure in cognitiveand emotional development - growth cycle and brain activity. Unravelling the processes underlying social, emotional and personality development.

**Unit IV** Psycho-social perspective

Dialectical models of socialization. Development of self-regulation and morality. Pro-social behaviour development- development across lifespan and correlates. Religious and spiritual development through

life span – positive and negative correlates. Issues concerning children in difficult circumstances. Multilevel perspective on child maltreatment. Resilience in the face of adversities. Socio-emotional development in diverse family contexts. Gendered development. Future directions for life course and behaviour genetics.

**HDFS-602 Ecology and Human Development** **3+0** **Sem. II**

**Unit I** Ecological modelling in human development

Ecological modelling in human development Human ecology – concept and relevance in understanding human development. Ecological modelling, ecology of developmental processes, bio-ecological model of Bronfenbrenner. Developmental ecology through space and time. The Process–Person–Context–Time (PPCT) Model . An Integrated model of individual development based on PPCT Model. Life course development through ecological perspective.

**Unit II** Physical ecology and human development

Physical ecology and human development :Developmental tasks through lifespan – role of ecology, social roles and structural role of ecology. Behavioural development – role of physical ecological factors, terrain, climatic changes, demographics and their effect on human development. Children's physical environment, housing, overcrowding, neighborhood and development. Economic factors and their impact on human development.

**Unit III** Socio-cultural ecology and human development

Socio-cultural ecology and human development .Building blocks in the environment. Interpersonal structures as context of human development. Dyads- types, nature and function of joint and molar activities, affective relations, balance of power. Race, class, ethnicity and development. Socio-cultural and sub-cultural context of human ecology and development- differences in child's ecological systems and their impact on parenting and development. Socio-cultural imbalances and their impact on human development. Contemporary child rearing and implications for human development. Impact of time factor and cultural history on development.

**Unit IV** Role of systems and policies

Role of systems and policies Children's institutions, day care and preschools as context of human development. Children in war and disaster. Socio-political, legal systems and policies and human development. Religion, caste, minority and deprived states and their effects. Community support and its value for human development. Impact of media, technology and social networking. Policies, programmes based on ecological factors impacting human development. Research and assessment of human development based on ecological perspective.

**HDFS-603 Programme Development for Vulnerable Families** **2+1** **Sem. I**

**Unit I** Family Vulnerabilities

Family Vulnerabilities Vulnerable families- meaning, categories, forms of vulnerability, characteristics. Family vulnerability factors - poverty, alcohol and drug abuse, AIDS, prostitution, delinquency, social disadvantages, mental disorders, chronic serious health issues, destitute women and children, street children, abused children, women and senior citizens. Impact of family vulnerabilities on children and families.

**Unit II** Programmes for vulnerable families

Programmes for vulnerable families Developmental programmes for vulnerable families – concept, history and five year plans. Types of programmes and projects for vulnerable families. Different approaches to develop programmes for families. Inter disciplinary approach to research project management. National and international research projects for vulnerable families. National and International programmes and policies for vulnerable children and families. UNICEF framework for protection, care and support of orphans and vulnerable children. National Plan of Action for protection and care of children.

**Unit III** Programme development – elements and process

Need assessment of vulnerable families. Developing need based multiple programmes for vulnerable families and children - project proposal, principles of project design, pects of appraisal, basic

considerations, risks and returns in project proposal development. Elements of effective programmes for families. Project sustainability- factors, components and action plan. Scientific values and professional ethics in development of programmes for vulnerable population. Donors and funding agencies- types, National and International donors funding projects. Role of public and private donors in funding projects.

**Unit IV** Working with vulnerable families

Working with vulnerable families- need, goals and significance. Developing strategies to support vulnerable children and their families. Strategies for increasing participation and retention. Ethics in working with vulnerable families. Working with children in vulnerable families- need, goals, strategies. Family resilience in the face of adversities- concept, risk and protective factors. Strengthening family relations. Including fathers in work with vulnerable families. Implementing the stimulating management techniques- Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Line of Balance (LOB), Gantt Chart and SWOT analysis.

**Practical** : Review of the national international projects and programmes for vulnerable families. Discussion on programmes and research projects .Developing need assessment performa Learning to use selected PRA techniques – i). Focus group discussions/ interviews ii.) Transit walk, social mapping and time line Interviewing families with need assessment .Developing need based programme for vulnerable families. Class discussion on developed programme and enhancement. Programme implementation – Working with families and execution of developed programmes- home based approach . Working with families and execution of developed programmes- child centred approach. Programme Evaluation by using- Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM). SWOT analysis. Developing concept note for research project on vulnerable families Developing Multiple Programs for promoting family health with vulnerable Children. Dissemination / publishing of success stories, popular articles.

**HDFS-604 Strategic Developmental Intervention** **2+1** **Sem. I**

**Unit I** Developmental intervention – Concept and Significance

Intervention – definition, need and importance. Early intervention for promoting children's development - principles, assumptions, eligibility and success criteria, Theory and practice, biosocial developmental contextualism. Current orientation towards developmental intervention for children from birth to early school years. Children with developmental vulnerabilities and their characteristics. Sources of developmental vulnerabilities and resources. Risk - biological, other personal and contextual risks, impact of social inequality. Protective factors - influences on children's development. Neurological basis for developmental intervention needs- importance of early years, sensitive periods and factors influencing brain development.

**Unit II** Intervention approaches and framework

Need assessment for intervention, Contemporary issues and current trends in intervention. Intervention principles strategies and process. Theoretical frameworks in early intervention. Intervention models. Multi-disciplinary approaches to early intervention and programmes for motor, cognitive, language and social development. Characteristics of effective Intervention strategies. Framework for developing and implementing programs for children with developmental delays.

**Unit III** Intervention procedural guidelines

Early intervention therapy program- guidelines, purpose, program goals and objectives, program description, service delivery and role of other supportive team members. Types of early intervention therapies. Service delivery models in early intervention- child centred, parent centred, family centred, home based, center/school based. Role of personnel in intervention – role of physiotherapist, speech pathologist, audiologist, occupational therapist, behaviour therapist and developmental therapist. Developing network with other agencies. Resource Generation. Role of family and community in implementation of intervention programmes. Family as developmental context.

**Unit IV** Strategic planning and implementation

Planning and implementation of intervention programme. Utilisation of other local level services offered to children and families – screening, referral, assessment, family education and support. Arranging

services and family support, collaboration and teamwork with families and professionals. Collaboration and interdisciplinary practices. Professional and ethical behavior. Early intervention - operational standards, accountability and quality assurance, accreditation, program resources and service delivery. Evaluation of developmental intervention programmes – basic concepts, effectiveness, efficiency and economics. Government policies and provisions. Early intervention policies – an international perspective, program resources and service delivery. Evaluation of developmental .Intervention programmes – basic concepts, effectiveness, efficiency and economics. Government policies and provisions. Early intervention policies – an international perspective.

**Practical** : Compilation of research reviews on various developmental Interventions for young children. Observational visits to intervention unit to understand the organizational structure, objective, types of services provided, facilities available, frequency, duration & cost of the Intervention etc. Observational visit to Paediatric Intervention unit to understand the process / steps followed in Intervention programme Observational visits to any National Institute offering Intervention programmes for children with developmental delays. Observational visits to any NGO offering intervention programmes for children with developmental delays. Identification of groups for intervention and Developmental assessment Conducting need based assessment to identify target groups in need of intervention using Developmental Screening test / appropriate psychological tests . Preparing developmentally appropriate intervention package for the selected group . Involving parents in the intervention programme, offering home based parent education programmes for managing children with developmental delays. Field testing the developed intervention package at – i) Day care centers/ pediatric wards ii) Clinics/ special schools . Conducting home based intervention programme for children with developmental delays . Conducting center-based interventions at – Day care centers/ pediatric wards / Clinics/ special schools . Developing a checklist for assessing the quality & effectiveness of the intervention packages. Evaluation of developed intervention programmes.

**HDFS-605 Family Studies** **3+0** **Sem. I**

**Unit I** Theoretical frameworks and perspectives

Different frameworks to understand families-conceptual framework, institutional, developmental and interactional framework. Family theories- Family Systems Theory, human ecology Theory, life course perspectives, social-cognitive-behavioral Theory, biosocial Theory and family communication theories. Family perspectives- Parson's sociological perspective, Marxist perspective, feminist perspectives, modern perspective.

**Unit II** Family assessment

Different approaches to Family research- demographic, psychological, psychiatric, ethnographic and inter disciplinary approach. Measurement of family roles and relationships. Ethics in family research. Current issues for research in Indian families in different communities- rural and urban.

**Unit III** Family under transition

Indian family system and changing patterns. Fatherhood- changing role of parents. Global migration- demographics, nature, contemporary migration patterns and effects. Cultural identity, family change and transnational mothering. Influence of globalization on children, youth, aged and families. Work and family interface – changing nature of work, feminization of the labour force and changing nature of family life and family roles. Diverse families -single parent families, female headed households, dual career families, one child family, adoptive families. Marital distress, family disorganisation.

**Unit IV:** Family therapy

Evolution of family therapy. Early models and basic techniques of family therapy- group process and communications analysis. Classic schools of family therapy- Bowenian family systems therapy, strategic, structured and experiential therapies, solution focused therapy,narrative therapy, psychodynamic therapy and integrative models. Cognitive behaviour family therapy. Application of family therapy in mental disorders. Family resilience- concept, developmental systems perspective, advances and challenges in family resilience research.

**HDFS-606 Adulthood and Aging** **3+0 Sem. II**

**Unit I** Aging perspectives and developmental changes

Socio demographic profile of the aged in Indian context. Biological theories of aging,programmed aging theories, random damage theories. Stochastic theories, evolutionary theories . The Aging body - physical, sensory, cardiovascular, brain and central nervous system changes. Changes in bodily systems - muscular and skeletal system, respiratory system, immune system. Cognition during adulthood- fluid and crystallized intelligence, decline/ stability in intelligence, dialectic operations, memory, multidimensional changes. Cognitive neuroscience and aging. Healthy aging.

**Unit II** Aging personality

Personality changes during late adulthood. Personality types among the elderly. The Five- factor Model of dispositional traits by Tupes and Christal. Neugarten's Personality Styles. Levinson's Theory of Social development, Carl Jung's theories- personality, psyche & dreams. Peck's Theory of personality adjustment in late adulthood. Erikson's Theory. Disengagement Theory. Information-processing in old age- attention, memory, pathological changes in memory. Cognitive disorders- dementia, Parkinson's disease and Alzheimer's disease. Aging and sexuality, illness and sexuality.

**Unit III** Aging in the family context

Aged in the family milieu- family relationships, problems, prospects and support systems. Attachment and relationships in late adulthood. Aging and mental health, Mental health risks and disorders. Loneliness, depression and sociability in old age. Indicators of successful and positive aging. Agingand financial status. Elderly abuse. Stress among the aged and coping strategies. Grief and bereavement-patterns of bereavement and stages of grief. Dying with dignity.

**Unit IV** Aging in the current scenario

Contemporary socio-cultural changes and aging. Aging in the current scenario-impact of urbanization, globalization and migration. Dual career families and aging, stress among caretakers and sandwich generation. International scenario of the aged. Critical issues around global aging. Reconceptualising aging. Researchable issues related on aging. Welfare of the aged- policies and programmes. Research trends in gerontology and methodological issues.

**HDFS-607 Mental Health** **3+0 Sem. I**

**Unit I** Mental health - Issues and theories

Mental health – concept, biological and psychological basis, historical perspectives. Concept, criteria and measurement of normality and abnormality. Cognitive functions - normal and pathological. Theories of mental health - behavioural, biological, humanistic, existential, psychoanalytical and related theories. Family and mental health. Gender and mental health. Sociology of mental health. Culture and mental health.

**Unit II** Mental health disorders

Types, etiology and behavioural symptoms of various mental health disorders and maladjustments psychosomatic problems, anxiety disorders, mood disorders, schizophrenia and multiple personality disorders. Clinical manifestation and effects / consequences of mental disorders cognitive disturbances, affective disturbances, functional impairments, addictions, alcoholism, substance abuse, gambling, other addictions and social networking.

**Unit III** Behaviour assessment and modification

Identification and assessment of mental disorders – approaches to diagnosis of mental disorders, techniques, steps in mental health assessment. Diagnostic and Statistical Manual of Mental Disorders (DSM) IV and DSM V. Psychological assessment - Role of mental health professionals. Strategies for behaviour modification - behaviour therapy, cognitive therapy, psycho therapy and family therapy.

**Unit IV** Mental health programme and policy

Status of mental health in vulnerable population – children, adolescents, women and senior citizens in India and abroad. Contemporary intervention techniques. Mental Health Policy – legislations, programmes and policies for the promotion of mental health in India.

**HDFS-608 Qualitative Research Methods** **1+1** **Sem. II**

**Unit I** Introduction to qualitative research

Qualitative research design- concept, need and scope of qualitative research methods. Types, contribution, overview and Practical applications of qualitative research methods.

**Unit II** Qualitative research methods

Case studies, naturalistic design, historical methods, content analysis, ethnography, single cases experimental design, grounded Theory, phenomenology.

**Unit III** Qualitative data analysis and interpretation

Coding procedures, analysis and interpretation of qualitative data. Report writing. Evaluation of qualitative research.

**Unit IV** Issues in qualitative research

Trends, challenges, limitations and constraints of various qualitative research methods.Ethical issues in conduct of research.

**Practical :** Critical review of research papers using qualitative methods. Critical analysis of research papers using qualitative methods . Extensive review of the empirical research works using qualitative method . Preparing any one review paper using qualitative methods . Identifying researchable issues that can be researched for qualitative methods . Designing qualitative research, site selection, sampling. Data collection by using qualitative methodsi) Conducting in-depth interviews ii) Focused group interviews iii) Naturalistic design iv) Historical method v) Ethnography vi) Single cases experimental design vii) Grounded Theory. Coding procedures, data analysis . Report writing and presentation . Ethical issues in qualitative methods.

**HDFS-691 Seminar I** **1+0**

**HDFS-692 Seminar II** **1+0**

**HDFS-699 Ph.D. Research** **0+75**

**Certificate Course in Early Childhood Care and Education (1 year)**

**HDFS 51 Personality and Value Education** **1+2** **Sem. I**

Personality-meaning, types and basic structure of personality. Factors affecting personality. Problem solving and decision making skills. Significance of high self-esteem and positive attitude. Motivation: meaning and importance. Value Education-meaning and significance. Fundamental values viz. right conduct, peace, truth, love and non-violence. Empathy, compassion & communal harmony. Civic Sense, Prosocial & selfless behavior, Emotional, social, spiritual and digital quotient. Work ethics and social etiquettes.

**Practical:** Techniques of personality assessment. Participation in group discussions, extempore and team games to understand various aspects of personality. Project talks and case studies to share experience related to self-esteem, stress, time management, positive attitude and motivation. Exploring strategies to handle conflict (personal & professional). Discussion on current scenario of value system. Studying motivational content available on online platforms and print media. SWOT analysis and self-exploration exercises.

**HDFS 52 Early Childhood Care and Education** **3+1** **Sem. I**

Meaning, need, importance, scope and objectives. History of early childhood education.Principles of Montessori Education. Types of early childhood care and education programmes – nursery schools, day care centres (Creche), anganwadi and after school care. Current issues of early childhood education in India. Agencies promoting and monitoring early childhood education. Principles and types of curriculum planning. Importance of play. Significance, types, selection, arrangement and maintenance of play and play materials. Use of indigenous resources. Planning age specific activities. Qualities and responsibilities of early childhood education personnel. Parent involvement in early childhood education programmes.

Developmental milestones. Physical, language, cognitive, moral and socio - emotional development during infancy and early childhood. Common behavioral problems of children and disciplinary techniques. Importance of early stimulation.

**Practical:** Recording observations regarding routine activities of early childhood care and education centres viz nursery schools, day care centres (Creche), anganwadis and after school care. Planning age appropriate group/ individual activities for all round development of children. Identifying and reporting contemporary behavioral problems of children through literature and home visits. Planning and conducting parent education programmes in early childhood care and education centres.

**HDFS 53 Developmental Assessment of Young Children 2+2 Sem. I**

Definition, need and functions of assessment. Screening and measurement concepts. Trends and challenges in developmental assessment of young children. Tools and techniques of assessment, significance of developmental milestone in assessment and screening. Screening and diagnostic assessment of young children for various developments thorough different tools and techniques .Interpretation of assessment. Basics of interpretation and report writing. Anthropometry- definition, instruments used in anthropometric measurements. Case study-definition, advantages and disadvantages, Identification of developmental delays. Ethical issues in assessment of children.

**Practical** : Screening and diagnostic assessment of young children for various developments. APGAR early screening profile. Anthropometric measurements. Motor and behavioral assessment using Bayley's Scale for infant Development and McCarthy's Scale for measurement of Cognitive Abilities of children. Recording and interpretation of assessment report writing. Planning of assessment based developmental programme for young children.

**HDFS 54 Participation in Early Childhood Care and Education Services 1+3 Sem. I**

Early Childhood Education- meaning, characteristic and significance. Early Learning Environment: Setting up Classroom, Learning/ Activity Centres, Displays on Walls, Furniture and Mats, Shelves and Storage. Essential Learning and Developmentally appropriate Play Materials: Indoor and outdoor. Curriculum planning: Short term and long term. Types of early childhood care services. Importance and need of early childhood care services. Developing skills in long-term and short-term curriculum planning. Personality and role of a childcare provider. Learning to address emergencies, Role of ECCE teacher.

**Practical** : Hands on experience in operationalization of the early childhood care and education programmes-planning activities for physical, cognitive, language, socio-emotional and moral development. Designing and development of age appropriate learning materials for different concepts. Conducting activities for furthering all aspects of development, learning to address emergencies.

**HDFS 55 Identification and Management of Differently Abled Children 2+2 Sem. II**

Differently-abled Children: Definitions, terminology. Special Education: Concept, need, importance and role. Definition, classification, etiological factors, characteristics, educational considerations and management of Mentally Challenged, Visually Impaired, Hearing Impaired, Physically impaired children. Definition, classification, etiological factors, characteristics, educational considerations and management of children with Speech and Language Difficulties, Learning Difficulties, Autism and Emotional Disorders. Giftedness: Definition, classification, etiological factors, characteristics, educational considerations and management. Rights and provisions for differently abled children in India. Intervention-concept, need, importance, approaches and steps involved in formulation of IEP (Individualized Education Program).

**Practical :** Visit to institutions catering to the needs of differently abled children. Observing and recording the functional programmes and interventions in these institutes. Selection of a differently abled child and preparation of a case study. Developing remedial programmes and conducting need based interventions. Evaluation of intervention programmes. Planning and organizing educational programmes for families to support differently-abled children. Presentation of case study.

**HDFS 56 Creative Experiences for Young Children 2+2 Sem. II**

Concept, significance, objectives and aspects of creativity. Types of creative expression. Sources of creativity. Role of creativity in the development of a child-physical, social, emotional, cognitive and

language. Fostering creativity among children at home and in school. Role of media in creative experiences. Training personnel in providing creative activities for children. Definition, need and significance of dramatic and rhythmic activities for children. Aims and purpose of drama for young children. Understanding the basic elements of drama such as sound, rhythm, movement, mime, gestures and speech. Unstructured and structured drama. Role of drama in overall development. Story telling. Role of teacher in planning dramatic and rhythmic activities. Need, significance, characteristics and types of literature for young children. Principles of developing literature for different age groups. Types and significance of folk tales, folk songs, fantasy and fairy tales, poetry, picture books, short stories, comics, cartoons, science, fiction and literary books. Role of parents, teachers and children's library in developing good study habits.

**Practical :** Survey of indigenous and modern creative materials for school children. Planning and conducting programmes for early childhood care and education for different creative activities. Setting and conducting various creative activities for children like painting, drawing, printing, paper craft, cutting and pasting, clay modelling, paper machie, garlands etc. Preparing collage, masks and puppets. Toy making out of waste, card making. Developing creative art resource files for children. Preparation of different material for dramatization and rhymes. Survey of available children's literature in the market. Reviewing website and application available online for popular topics. Developing knowledge and skill in presenting children's literature using variety of methods

**HDFS 57 Entrepreneurship in Childhood Care and Education Services 2+2 Sem. II**

Project proposal, Assessment and types of needs, regulations governing early childhood programme. Registration, certification and licensing .Infrastructure development. Building and fixtures, furniture, play equipment and material, Finance-fund raising through loans, budget and accounts. Personnel: Staffing and Supervision. Curriculum: Goals and Objectives. Administration: Policies and planning. Setting the learning environment, short term and long term programme planning and evaluation.

# DEPARTMENT OF RESOURCE MANAGEMENT AND CONSUMER SCIENCE

## PROGRAMMES

**M.Sc.**

**Ph.D.**

**Certificate Course in Interior Design and Decoration (1 year)**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Field of specialization | Ergonomics, Resource Management |
| Required courses | RMCS-501, RMCS-502, RMCS-503, RMCS-504 |
| Supporting courses | Stat.-502 and Ext.-504 or other courses from subject matter fields(other than minor) relating to area of special interest and research problem. |
| Minor field | Business Management, Apparel and Textile Science, Sociology, Extension Education and Communication Management, Food and Nutrition, Human Development and Family Studies or any other as approved by the Dean Postgraduate Studies. |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency Courses for students with Elective other than Resource Management and Consumer Science / Family Resource Management | As Recommended by the Students' Advisory Committee and approved by the Dean Postgraduate Studies |

### Ph. D.

| | |
|---|---|
| Field of specialization | Ergonomics, Resource Management |
| Required courses | RMCS-601, RMCS-602 |
| Supporting courses | A student can opt any course related to the topic of research offered by other faculties of Agriculture University or SWAYAM portal or other online courses up to a maximum of 5 credits. |
| Minor field | Business Management, Apparel and Textile Science, Sociology, Extension Education and Communication Management, Food and Nutrition, Human Development and Family Studies or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by Student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**FRM 101 Management of Resources and System Dynamics** **1+1** **Sem. I**

Importance of resource management. Origin, classification and role of motivating factors of management-values, goals and standards. Resources – definition, types, guidelines and factors affecting their use, management of household resources. Management process: planning - importance, types, characteristics and techniques; organizing; controlling- definition, phases and factors;evaluating- definition and types of evaluation. Time - tools and process of time management. Decision making process - types, steps and factors affecting decision making. Money - management process, types and sources of income, steps in making budget, controlling budget and evaluation of budget. Systems approach to management.

**Practical :** Identification of individual and family values, identification of immediate, short term and long term goals of individual and family. Standards for individual and family goals.

Decision making by individuals and families. Applying decision making process, group work presentation on types of decision and decision making process. Listing out human and non – human resources, listing community resources. Application of management process to organize an event – planning,organization, evaluation. Management of personal time record for a week. Presentation of personal time record.

**FRM 102 Housing and Space Management** **2+1** **Sem. II**

Housing - its importance and characteristics. Factors to be considered in selection of family housing. Housing needs at different stages of family life cycle. Selection of site. Principles of house planning - orientation, privacy, grouping, roominess, sanitation, ventilation, flexibility, circulation, economy, furniture requirement. Housing standards - sanitary facility, food preparation and refuse disposal, space and security, thermal environment, illumination and electricity, structure and material, interior air quality, water supply, site and neighborhood. Sanitary condition and smoke detectors. Types of house planning – floor plan, site plan, cross sectional plan, perspective plan, elevation plan and landscape plan. Advantages and disadvantages of renting and owning a house. Technology in housing – advance technology in housing construction, low cost building technology, low cost building materials. Economy in housing construction. Ergonomics and housing - space management and interior types based on functional needs, interior for youth, elderly andother special needs, functional design of areas in interior. Housing problems – rural and urban housing problems in India. Housing policies – government and non-government housing policies and housing schemes. Housing finance - government and non- government finance institutes. Building bye-laws.

**Practical :** Learning architectural symbols. Drawing of house plans for different income levels and activity groups. House plan for renovation according to needs of residents. Designing of kitchen, bathroom etc. for special needs. Market survey to study the available building materials in the local market.

**FRM 201 Fundamentals of Art and Interior Enrichment** **1+3** **Sem. I**

Introduction and objectives of interior decoration. Elements of art and their importance in interior decoration. Principles of design and their application to interior enrichment. Colour- sources, properties and emotional effect of colour, colour schemes, colour theories and colour plans for interiors. Furniture – types of furniture, materials and finishes used for furniture, factors affecting the selection, care and maintenance of furniture, furniture arrangement. Walls – types of walls, functional characteristics of walls,types of wall treatments, exterior and interior wall finishes. Floors - importance, types of floors and floorcoverings, selection, care and maintenance of floor coverings. Windows – importance, functional and decorative treatments. Accessories – classification, selection/ development and their placement. Lighting – importance, types of lighting. Flower arrangement – principles, types, material used, utility and care. Table setting – linen and tableware required for table setting. Table etiquettes.

**Practical** : Application of elements of art and principles of design. Development of motifs and designs through art principles. Colour – colour schemes, value and intensity scale, colour wheel. Furniture –

care and arrangement of furniture. Preparation of scrap book for different types of furniture and furniture arrangement. Site survey – different types of wall and floor coverings. Use of floor decoration in interiors. Window treatments. Accessories - preparation using painting/ printing methods, calligraphy, pottery, collage, paper machie, paper sculpture, poster making, greeting cards, fabric painting, glass painting, gift wrapping, placement of accessories. Lighting - fixtures and their utility. Flower arrangement. Learning different types of table setting and napkin folding.

**FRM 202 Ergonomics in Household and Farm Technologies 1+2 Sem. II**

Ergonomics - Introduction and principles. Work - worker and workplace relationship, work simplification techniques. Household drudgery - definition and drudgery reduction techniques. Household equipment -introduction, definition, classification of base materialsused in equipment. Impact of household equipment on work, worker and environment. Equipment design and its effect on body posture. Women friendly agricultural tools. Energy – definition, classification and sources. Causes of energy crisis and solutions. Status of energy crises in India and abroad. Renewable and non-renewable energy saving technologies and methods of energy conservation in household and community.

**Practical :** Motion studies – process and operational charts. Kitchen organization and storage principles. Introduction to drudgery reducing postures, tools and equipment in home andfarm. Identification of base materials and finishes used in household equipment. Useand care of common household appliances - refrigerator, washing machine, dishwasher, cooking range, vacuum cleaner, OTG, microwave oven, food processor, coffee maker, toaster and sandwich maker. Demonstration of solar household technologies, zero energy cool chamber. Visit to biogas plant.

**FRM 301 Family Finance and Consumer Education 2+0 Sem. I**

Concept, importance, objectives and major aspects of family finance. Income and its types - productive, hidden, money, real and psychic. Family as income producing and utilizing unit, factors affecting the use of family income. Analyzing income - income profile, methods of handling income and account-keeping. Family budget: steps of budget making, factors influence on budget making, advantages of budget making. Engel's law of consumption. Standard of living. Credit - needs, types, sources and use. Planning for financial security of families. Savings and Investment- types of savings and investments. Saving institutions and their importance. Criteria for calculating family investments. Taxation -objectives, characteristics and classification. Consumer – definition, role, concept of consumer economics. Problems of consumers in rural and urban areas - unfair trade practices, adulteration, faulty weights and measures. Consumer Rights and responsibilities. Consumerism and consumer protection - history of consumer movement and growth of consumerism. Consumer Protection Act, Government legislations and orders. Role of NGOs in consumer protection and welfare. Standards, standardization and legislative measures for regulating quality. Sources of consumer information – advertisements,labels, packaging. Consumer and environment.

**FRM 302 Residential and Commercial Space Design 2+1 Sem. II**

**(In collaboration with Department of Civil Engineering)**

Introduction to design and space organization. Functional requirements of a building. Building bye-laws, regulations and specifications for residential and commercial buildings. Building materials, recent advances in materials, different tests for materials, mode of measurements for material requirements. Pre and post execution. Specification writing. Estimation of cost of fittings, fixtures, furniture, lighting, air conditioning, thermal insulation, solar panelling and finishing materials for residential and commercial buildings. Appraisal on space needs in commercial buildings. Study of commercial interiors for business establishments, hotels/restaurants, hospitals, educational buildings and public service buildings. Analysis of independent houses, apartments and flats of different income groups. Rural housing details.

**Practical :** Develop conceptual drawings and floor plans for various income groups. Develop layouts of furniture, lighting, electrical and plumbing for various income groups. Practical applications of design and space organization of apartments and flats and analysis. Cost estimation for designing interiors of various income groups. Planning of ergonomic work layout for a small project (1000 sq.ft.). Planning of ergonomic work layout for residential and commercial areas. Evolving interior decoration details

with material sample for the small project. Evolving interior decoration details with material sample for rural, urban residential and commercial areas. Presentation of the detailed work done for small projects. Presentation of the detailed work done for small and large commercial projects.

**FRM 401 Seminar** **1+0** **Sem. I**

**FRM 402 Experiential Learning I -Art Creations** **0+8** **Sem. I**

**Practical :** Developing business plan for 'Artistic Creations, Survey of art galleries for need assessments and identification of products to be prepared. Exploration of target markets and customers. Preparation of detailed project proposal with inputs required, personnel plan, production plan, funds required sales strategy, sales volume, profit to be generated and pay back period.

**FRM 403 Experiential Learning II -Marketing Management of Art Creation** **0+12** **Sem. I**

**Practical** : Planning for production, organization of resources, delegation of duties, sequential grouping of activities production of items, product pricing packaging and storage of articles, monitoring production, product quality assessment, maintenance of production records, marketing of products, preparation of final report, oral performance.

**FRM 412 Internship I - Entrepreneurial Placement/Inplant Training** **0+8** **Sem. II**

**Practical :** Training of the students in art centers, with interior designing and architects to develop industry oriented scale and acquire Practical experience in actual work environment.

**FRM 413 Internship II - Project Report and Presentation** **0+2** **Sem. II**

**Practical :** raining of the students to identify the problem, develop tools to collect data, analyze and interpret the data. Report writing and presentation.

## Postgraduate Courses

**RMCS-501 Resource Management: Principles and Practices** **3+0** **Sem. I**

**Unit I** Nature and functions of management

Importance of management; Management functions; Management principles; Management levels; Functional areas of management; Managerial skills; Managerial roles.

**Unit II** Evolution of management thought

Early classic approaches- Scientific management, administrative management and bureaucracy; Neo-classic approaches- Human relation approach and behavioral approach; Modern approach; Quantitative approach; Systems approach; Contingency approach.

**Unit III** Managerial competencies

Planning and administrative competencies; Decision making- Introduction, nature of managerial decision making, approaches to decision making; Types of decisions; Process of decision making; Tools and techniques of decision making; Creativity and rationality in decision making; Models of decision making behaviour; Risk and certainty in decision making; Authority and responsibility in decision making; Communication- Functions, factors and features, process, barriers and principles, types and channels; Leadership- Meaning, importance, characteristics and styles.

**Unit IV** Management process

Steps in management process; Planning- Types and dimensions, planning in systems perspective, factors affecting planning; Organizing- Departmentalization, line and staff relationship; Coordinating – Need, types, principles, techniques and problems of coordination; Directing; Controlling.

**Unit V** Human behaviour and organization

Introduction to organizational behaviour; Values; Attitudes and performance; Motivation- Importance, contemporary theories of motivation, approaches, elements of sound motivation; Stress management- Concepts, causes, consequences, stress managing techniques.

**RMCS-502 Human Factors and Ergonomics** **2+1** **Sem. II**

**Unit I** Introduction to ergonomics

Definition, aim, objectives and scope of ergonomics; Domains of ergonomics; Historical development of ergonomics and human factor; Interface between man machine and environment; Ergonomics in design.

**Unit II** Human body systems

Structure and functions of major body systems- Parts and basic functions of skeletal system; Properties and functions of muscular system; Components of circulatory system; Parts and functions of respiratory system; Structure and functions of digestive system and nervous system.

**Unit III** Human anthropometry

Human anthropometry; Static and dynamic anthropometry; Anthropometric measurements; Normal distribution and percentiles; Anthropometry in ergonomics and design.

**Unit IV** Body movement and postures

The functions and movements of skeletal system - Functional classification of bones, joints, ligaments and tendons; Neuromuscular aspects of movement; Joints and movements; Classification of joints on the basis of function; Movement at synovial joints; Skeletal muscle as levers; Posture- Work posture, postural discomfort and its impact on work and human health, posture analysis tools.

**Unit V** Work physiology

Fundamentals of work physiology; Muscular efforts; Energy consumption; Physical fitness-Measuring physical fitness using different techniques; Physical work capacity and its measurement; Determination of cardiac cost of work; Factors influencing energy requirements and energy costs for various activities.

**Practical** : Collection of anthropometric measurements of school children; Analysis of data on school children anthropometry; Presentation of report on school children anthropometry; Designing study table based on the anthropometric data; Measuring the work posture of a worker involved in manual work using RULA/REBA/OWASA; Analysis of work posture data Presentation of report on work posture of person involved in manual work; Determination of physical fitness using any one of the technique; Analysis of data and presentation of report on physical fitness; Measurement of cardiac cost of selected activity, Analysis of data on cardiac cost of selected activity; Presentation of report on cardiac cost of selected activity; Assessment of ergonomic cost of work in terms of physiological indices; Analysis of data on ergonomic cost of work; Presentation of report on ergonomic cost of work; End term Assessment.

**RMCS-503 Interior Space Planning** **1+2** **Sem. I**

**Unit I** Interior design and user comfort

Residential buildings- Types and its characteristics; Commercial buildings- Types and its characteristics; Effect of interior design on user comfort- Residential, commercial, special needs.

**Unit II** Building planning principle

Functional and aesthetic considerations in the use of elements of design; Functional and aesthetic considerations in the use of principles of design; Housing principles for designing public private and circulation spaces; Advances in design process of residential interiors- Personal space, public space, utility space; Advances in design process of commercial interiors- Service institutions, marketing institutions; Recent trends in interior space management.

**Unit III** Space standards

Space standards for various rooms in residential and commercial buildings; Building materials and their standards; Space saving furniture.

**Unit IV** Building services

Electrical and safety fittings; House wiring; Plumbing systems for residential and commercial buildings; Sanitary fittings and fixtures for residential and commercial buildings.

Practical : Preparation of a schedule to collect information regarding the characteristics of residential and commercial buildings;Visits to identify the characteristics of residential buildings; Visits to identify

the characteristics of commercial buildings; Presentation of report on characteristics of residential and commercial buildings;;Designing a residential house as per space standards –development of conceptual drawings ;Designing a residential house as per space standards –development of design details and working drawings; Designing a residential house as per space standards –portfolio preparation ;Designing a residential house as per space standards –presentation and group discussion; Designing any commercial building as per space standards- development of conceptual drawings;Designing any commercial building as per space standards- development of design details and working drawings; Designing any commercial building as per space standards- portfolio preparation; Designing any commercial building as per space standards- presentation and group discussion; Market survey on electrical and sanitary fittings and fixtures ;Market survey on space saving furniture suitable; Presentation of report on sanitary fittings, fixtures and space saving furniture for residential and commercial buildings available in market; Cost estimation of residential building (apartment/condominium/row house); Cost estimation of commercial building (Ice cream parlor/Tiffin centre/beauty salon/ restaurant etc.); Designing space saving furniture for residential buildings; Portfolio preparation on space saving furniture for residential buildings; Presentation of report on space saving furniture for residential buildings; Design and development of space saving furniture for commercial buildings. Portfolio preparation on space saving furniture for commercial buildings; Presentation of report on space saving furniture for commercial buildings; Project on renovation of a residential building with cost estimation; Portfolio preparation on renovation of a residential building with cost estimation; Presentation of report and group discussion on renovation of a residential building with cost estimation; Project on renovation of a commercial building with cost estimation; Portfolio preparation on renovation of a commercial building with cost estimation; Presentation of report and group discussion on renovation of a commercial building with cost estimation; Preparation of material board and presentation for a residential project; Preparation of material board and presentation for a commercial project; End term assessment.

**RMCS-504 Consumer Economics** **2+1** **Sem. I**

**Unit I** Consumer behaviour Consumer behavior; Environmental influences on consumer behaviour; Individual determinants of consumer behavior; Models of consumer behavior - Micro economic model, Nicosia model, Howard-Sheth model, Engel- Block well-Miniard model; Application of consumer behaviour knowledge in marketing; Consumer decision process- Problem recognition, search and evaluation, purchasing process, post purchasing behavior; Researching consumer behaviour.

**Unit II** National income

Definition and significance; Concepts of national income; Methods of measurements of national income - Value added method, income method, expenditure method, reconciliation of the three measures of national income; Difficulties in measurement of national income- Conceptual difficulties and Practical difficulties; National income and Economic welfare.

**Unit III** Consumption economics

Concept of consumption economics; Theories of consumption- Engels law of consumption, relative income Theory of consumption, life cycle Theory of consumption, permanent income Theory of consumption; Budget and economy; Fiscal policy; Annual financial statement of the government and budget; Revenue receipts and revenue expenditure; Capital receipts and capital expenditure; Overall budget; Concepts of deficits in government budget; Revenue deficits and fiscal deficit; Taxation- India's tax structure; Tax as a source of public revenue; Direct and indirect taxes; Merits and demerits of taxes; Role of indirect tax in a developing economy; Incidence and effects of taxes; Inflation- Meaning of inflation, types of inflation, causes, effects, measures to check inflation; Deflation- Meaning, deflation and disinflation, causes, effects, measures to control deflation.

**Unit IV** Financial systems of India

Introduction to financial system of India; Financial institutions; Financial services; Financial markets; Structure of Indian financial system; Importance of financial system for the economic development ; Banking-Types of banking institutes; Functions; Types of loans and advances; Indian money market; Indian capital market; Financial intermediaries and services; Insurance and its regulations.

**Practical** : Project work: Study of consumer buying behaviour while buying a selected commodity – Collection of review; Formulation of objectives of the study; Selection of sample, and study location; Designing the data collection tool; Pre testing and finalization of data collection tool; Collection of data; Data analysis; Report writing, Finalization of report; Presentation of the report on "consumer buying behaviour while buying a selected commodity", Discussion on the findings of the research ; Visit to any one financial institute. Preparation of documents required for applying for a loan; Study other trends of stock market index given in magazines or news papers; Critical analysis of National Budgets through panel discussion; End term assessment.

**RMCS-505 Work And Workstation Design** **1+2** **Sem. II**

**Unit I** Work, worker and workplace

Work, worker and workplace-Definition, types and interrelationship; Classification of work based on energy consumption and nature of work; Time and energy requirements of work; Introduction to components of worker input- affective, cognitive, temporal and physical.

**Unit II** Work measurement techniques

Work measurement techniques- Subjective judgment, Record of past performance, Scientific methods; Tools for work analysis-Charts, diagrams, models and photographic aids.

**Unit III** Workplace layout and equipment design

Principles of workstation and system design; Design and arrangement of different work centers; Work reaches; Working heights; Visual design parameters- Work surface, space allowance and storage; Design considerations for different workstation designs-Seated work, Standing work, Sit stand work; Controls, displays and information; Visual, auditory and other displays; Quantitative and qualitative information; Methodologies for studying workplace design; Hazards of ill designed workstation.

**Unit IV** Physical factors of the work environment

Environmental factors in workplace and their measurement-Heat, light, sound and noise, vibration, radiation, humidity; Effect of environmental parameters on worker and work performance.

**Practical** : Selection of workplace unit for taking the anthropometric measurements of worker and dimensions of equipment and furniture used in a selected workplace units; Measuring and recording the anthropometric measurements of worker in the selected workplace unit ; Measuring and recording the dimensions of equipment and furniture used in the selected workplace unit; Working on developing design for a workplace unit as per data collected in previous exercise ;Determining the space relationships as per workers anthropometry; Determining the space relationships as per workers posture and movement at selected workstations; Developing the 2D design of selected workplace unit ; Developing the 3D design of selected workplace unit .Work measurement in the selected workstation using two hand process charts;Analysis of data collected ; Presentation of report on work done in the selected workstation using two hand process charts; Work measurement in the selected workstation using photographic aid; Analysis of data on work measurement collected in the selected workstation using photographic aid; Presentation of report on work done in the selected workstation using photographic aid; Measuring environmental factors in the workplace; Heat Measuring environmental factors in the workplace; Light Measuring environmental factors in the workplace:; Noise ; Measuring environmental factors in the workplace: Vibration; Measuring environmental factors in the workplace: Radiation;; Measuring environmental factors in the workplace: Humidity; Analysis of data collected on environmental parameters; Presentation of report on environmental parameters; Developing a design layout of a selected commercial workplace: Preparation of check list; Collection of data on design features, space relationships, dimensions of equipment and furniture, and environment control parameters in the workplace; Analyzing the data; Finalizing the dimensions of selected commercial workplace ; Developing a design layout of the selected commercial workplace based on the DATA.; Presentation and group discussion on the design layout of the selected commercial workplace; Finalization of design layout of the selected commercial workplace; Developing 2D plan of the selected commercial workplace; Developing 3D workplace design of the selected commercial workplace; End term assessment.

**RMCS-506 Colour and Lighting in Interiors** **2+1** **Sem. I**

**Unit I** Colour as an interior design element

Historical perspective of colour as an interior design element; Properties of colour - Hue, value and intensity; Approaches and theories of colour.

**Unit II** Applications of colour in various elements of interiors

Cultural and psychological effects of colour; Types of colour schemes-Related colour schemes, contrast colour schemes; Factors to consider while choosing colour schemes for buildings; Suitable colour schemes for residential, commercial, public, educational and religious building interiors.

**Unit III** Introduction to lighting in interior

Importance and sources of lighting; Cultural and social aspects of lighting; Physiology of vision; Properties of lighting - Reflection, absorption, transmission and diffusion; Types of lighting; Safety and emergency lighting; Lighting requirements for household activities; Lighting requirements in commercial buildings.

**Unit IV** Quantity and quality of lighting

Measurement of light and its units; Types of lamps from animal fat lamps to LEDs, their characteristics and suitability to various rooms; Types of lighting based on direction of use, place of use, purpose and portability; Lighting controls- Type, selection, care, maintenance and economic use; Lamp holders; Lighting switches; Motion sensors; Factors affecting the quantity of illumination in a room- Room proportion, colour, texture and cleanliness of room surface, lamp lumen, lamp lumen depreciation; Method of calculating lighting requirements for various rooms; Lighting for outdoor living and gardens.

**Unit V** Effect of colour on lighting

Colour rendition; Use of colour and lighting in architecture, materials and finishes from 16th century to the date; Use of colour and lighting in problematic areas to disguise and camouflage.

**Practical** : Study of types of colour schemes in residential interiors ; Study of types of lamps and lighting used in residential interiors ; Group discussion on use of colour and lighting in interiors ;Study of types of colour schemes in commercial interiors ; Study of types of lamps and lighting used in commercial interiors; Presentation on use of colour and lighting in commercial interiors; Suggesting suitable colour schemes for residential buildings and its cost estimation; Suggesting suitable colour schemes for commercial buildings and its cost estimation; Group discussion on suitable colour schemes for residential and commercial buildings; Suggesting suitable lighting fixtures for residential buildings and its cost estimation; Suggesting suitable lighting fixtures for commercial buildings and its cost estimation; Group discussion on suitable lighting fixtures for residential and commercial buildings; Prepare a colour and lighting plan for problematic areas like space below stair case and estimate the cost; Prepare a colour and lighting plan for problematic areas like, irregular shape rooms or narrow areas and estimate the cost; Market survey to understand the available safety and emergency lighting systems and presentation of report; End term assessment.

**RMCS-507 Consumer Issues and Legislations** **2+0** **Sem. I**

**Unit I** Consumer issues

Changing trends in consumerism; Profile of consumers in India and abroad; Consumer issues and challenges; Social media management; Consumer finance; Multiple tax structure: Gender issues in consumerism; Gender division of labour; Access to decision making; Marketing and gender consumerism; Wealth and gender consumerism; Green consumerism- Definition, objectives and necessity of green consumerism; Agriculture credit in India; Agriculture marketing in India.

**Unit II** Consumer Legislations

Significance of consumer guidance and counseling; Consumer protection measures- Legal and non-legal consumer legislations; The Contract Act 1982; The Sale of Goods Act 1930; The Essential Commodities Act 1955; The Agricultural Produce (Grading and Marking) Act 1937; The Standard of Weights and Measures Act 1976;The Trade Mark Act 1999; The Competition Act 2002;The Bureau of Indian Standard Act 1986; Consumer Protection Act1986;Consumer protection Bill 2018; Right to Information Act 2005; Information Technology Act 2000;Food Safety and Standards Act,2016.

**Unit III** Consumer and communication tools

Consumer communication- Significance, history and types; Communication media and social change; Trends in consumer communication; Media and consumer demand; Advertising as a mode of communication; Trends and impact of advertising on consumers; Social media- Chats, Blogs, Face book, LinkedIn, Twitter, Instagram, Pinterest, YouTube.

**Unit IV** On line marketing

E-marketing in India- Evolution; Growth and challenges; Legislative frame work.

**RMCS-508 PRODUCT DESIGN** **1+2** **Sem. II**

**Unit I** Introduction to product design

Product Design- Definition, significance and essentials of product design and consumer demand; Product attributes-Usability, contextual needs, compatibility, product aesthetics.

**Unit II** Approaches to product designing

Concepts in product designing; User-centered design; Universal design; Accessible design; Usable design; Anthropometry in product design; Design consideration in product for geriatrics; Design consideration in product for people with special needs.

**Unit III** Outsourced product development (OPD)

Introduction; Importance; Concept and need; Major differentiating factors- technology related, people related, process related; Emerging models of product development.

**Unit IV** Product development process

Stages of product development process; Market analysis; Product analysis; Identification and innovation; User-Product relationship and ergonomics; Cognitive and social engineering issues; User interface designing.

**Unit V** Product testing

Product testing- Definition, purpose, role of government, Industry and consumer organizations; Product testing techniques and devices-Product evaluation, quality control and standardization.

**Practical** : Checklist for evaluation of a selected consumer product against the manufacturer's guidelines-Literature survey; Designing a checklist for evaluation of a selected consumer product against the manufacturer's guidelines; Evaluation of the selected consumer product against the manufacturer's guidelines; Presentation and group discussion; 5-9. Exposure to Outsourced product development (OPD); Conceptualization and development of consumer products with functional alternatives;. Product Idea generation through brainstorming; Evaluation of the product idea generated; Group participation; Finalization of product ;. Working on design criteria ;Collection of feedback from market ; Analyzing the user's option on the design of the consumer product; Developing the prototype of the product; Evaluation of the product developed for identifying the problems through brain storming; Proposing design solutions to rectify identified lacunas in the product design; Finalization of product design; End term assessment.

**RMCS-509 ERGONOMIC RESEARCH TECHNIQUES** **1+2** **Sem. II**

**Unit I** Approaches to research methods in ergonomics

Measurement and information gathering; Ergonomic standards; Observational techniques; Rating scales; Questionnaires and checklist; Digital models and simulation.

**Unit II** Subjective assessment tools

NIOSH discomfort survey; The Dutch Musculoskeletal Nordic Questionnaire (DMQ); Nordic Musculoskeletal Questionnaire (NMQ); Cornell Musculoskeletal Discomfort Questionnaire; University of Michigan Upper Extremity Questionnaire (UMUEQ); Job stress Questionnaire; Work Style Questionnaire; NIOSH Generic Job Stress Questionnaire.

**Unit III** Postural evaluation tools

Ovako Working Posture Analyzing System(OWAS);Quick Exposure Checklist(QEC);Concise Back Screening Instrument(CBSI);Rapid Upper Limb Assessment (RULA); Plan for Identifying av Belastnings faktorer (PLIBEL); Rapid Entire Body Assessment(REBA);Model for Comprehensive Evaluation of Risks of Musculoskeletal Disorders(MODSI).

**Unit IV** Measurement of work effort and fatigue

Borg Rating of Perceived Exertion Scale; Muscle Fatigue Assessment Method; Hand Activity Level (HAL); The Occupational Repetitive Action (OCRA); NIOSH Lifting Equation); The Strain Index.

**Practical** : Collection of literature on occupational disorders in any one occupation such as Construction Industry/ Manufacturing industry; Review of collected literature to understand the type of disorders prevailing in the selected industry'; Elicit information on musculoskeletal disorders experienced by workers from a selected field using Nordic Musculoskeletal Questionnaire -Data collection; Discuss the merits and demerits of the tool /Propose modifications in light of demerits of the tool; Gain hands on experience on the use of a selected postural evaluation tool; Evaluation of posture adopted by sweepers using a selected postural evaluation tool Identify the level of risk ; Group discussion on the use of postural evaluation tool;Gain hands on experience on the use of a selected muscle fatigue assessment tool; Measure the muscle fatigue experienced by workers involved in manual work using the selected muscle fatigue assessment tool; Group discussion on the use of muscle fatigue assessment tool; Gaining hands on experience on the use of OCRA checklist Identify the risk of upper extremity work related musculoskeletal disorders among workers involved in repetitive work using OCRA checklist Develop a measuring scale to measure work stress: Collection of literature; dentifying the parameters to be included in the scale; Item collection Identifying the items to be included in the scale Validation of the tool; Collection of expert remarks on the items included in the scale; Modifying the scale as per the remarks of experts,Testing reliability of the tool- test retest method ; First phase data collection.; Second phase data collection; Testing the reliability Finalization of scale ;Pre testing of scale; Modifications as per the identified lacunas; Data collection in the field; Data analysis; Critical evaluation and finalization of the scale ' End term assessment.

**RMCS-510 Housing and Energy Efficient Building Design** **2+1** **Sem. II**

**(in collaboration with Dept of Civil Engineering)**

**Unit I** Socio cultural and economic issues in housing

Historical perspective of the architectural features of buildings; Ancient science of house design; Role of housing in developing economies; Economic impact of housing; Housing markets and housing policies in India; Housing finance; Role of Government and non- government organizations in providing and regulating housing needs.

**Unit II** Recent trends in building design

Emerging techniques in the house construction; Building design- Need and scope for energy use and conservation; Design parameters for visual comfort; Day lighting and artificial lighting; Recent developments in building bye-laws; Low-cost building materials and fabrication technologies; Estimation of construction cost and housing finance; Housing research in energy efficient building design.

**Unit III** Energy and climate

Structural features of residential buildings in different geo-climatic conditions; Environmental and architectural characteristics and energy consumption; Design parameters for climate and energy control; Eco and Ergo friendly house design; Low and zero carbon buildings and energy infrastructure.

**Unit IV** Energy efficient building design

Green building design- Concept; Need and scope for energy use and conservation in building design; Energy efficient design principles and guidelines; Techniques for improving energyefficiency in residential and commercial buildings; Energy efficient building materials and construction technology; Energy flow audit and economy; Energy economy in residential and commercial buildings; Energy efficiency building regulations; Housing and energy models-Residential and commercial.

**Practical** : Collection of information on building forms in different geo-climatic regions;Presentation and group discussion on building forms in different geo-climatic regions; Visits to organizations promoting green building technology; Collection of information on green building technology through literature search ; Presentation and group discussion on green building technology; Analysis of research trends in energy efficient building design; Panel discussion on energy efficient building design; Assessment of existing house plan in terms of energy efficiency; Suggesting suitable renovations to improve energy efficiency; Evolving Eco friendly housing plan for selected geo-climatic region - development of conceptual drawings; Evolving Eco friendly housing plan for selected geo-climatic region- development of design details; Presentation and group discussion; Housing research in energy efficient building design-review of literature; Estimation of cost of construction; Energy audit of a residential building; End term assessment.

**RMCS-511 TECHNICAL DRAWINGS** **1+2** **Sem. II**

**Unit I** Drafting fundamentals

Measurement and scaling; Lines-Types, quality and weights; Lettering styles; Sheet format and layout; Blocks and layout; Legend and dimension; Conventions and preliminary drawings.

**Unit II** Presentation techniques

Orthographic plans- Plan, elevations and sections; Design drawings; Projection drawings; Isometric drawings; Perspective drawings; Rendering and hatching techniques; Presentation boards.

**Unit III** Introduction to AutoCAD

Introduction to AutoCAD as 2D drafting tool; Digital drawings tools; Drawing lines and shapes; Modifying lines and shapes; Drawing with accuracy and speed; Organizing plans; Sections and elevations; Drawing and printing to scale; Text styles and sizes; Hatches and dashed lines; Stencils and blocks; Advanced editing tools and Dimensioning drawings.

**Unit IV** 3D Modelling using AutoCAD

Introduction to 3D-modelling technique using AutoCAD;3D basics– Axes, Planes and Faces;3D Object Modification– Rotate, Mirror, Array and Scale; 3D Boolean operations– Union, Subtract, Intersect;3D Primitive objects– Box, Wedge, Cone, Sphere, Cylinder, Torus and Pyramids; Solid modeling – Revolve, Shell, Taper, Loft, Path extrusion and Sweep.

**Unit V** Introduction to 3D Modelling and Rendering

Introduction to 3D Modelling and Rendering; Building Modelling and basic rendering techniques; Using 3DS Max or equivalent; Advanced 3D Modelling-Advanced modeling; Ray rendering engine.

**Unit VI** Auto CAD and its application in interior design

Orientation to AutoCAD Main screen and menus; Coordinate systems; Use of Draw and edit menus; Hatching inquiry tools;Layers;3D Modelling; Co-ordinate system; Primitive tools: Boolean operation; Editing 3D objects; Rendering; Printing; Introduction to ADT- Creation of plans, sections, elevations, title marks and dimensioning, schedule table of doors and windows; Create still camera views; Creating a movie file; Walk through; Introduction to 3D Max -Standard tool bar command panel; Concept of import and export of objects from ADT and Auto CAD to 3D Studio MAX; Creating objects in 3D Max using standard primitives; Using transforms; Introduction of material; Light; Colour; Render the images and save; Camera animation of walk through.

**Practical** : Drawing a detailed floor plan showing the use of different lines, lettering styles, sheet format and layout, blocks and layout, legend and dimension, section drawing; Drawing a detailed floor plan showing the use of blocks and layout, legend and dimension, section drawing; Scale drawing of building components in plan and elevation ; Preparation of electrical layout for a small building; Preparation of plumbing layouts for a small building; Working on presentation details for the above plans, Evolving floor plans for an existing residential building, Drawing views of brick arrangement to scale in two dimensions; (Plan, elevation) and three dimension (isometric, oblique and axonometric); Study of buildings and interiors in two and three dimensions; Drawing one/single perspectives of interiors' Drawing two point

perspectives of interiors' Creation of texture effects in interior objects; Pencil rendering of interiors; Colour rendering of interiors; Developing a private project and presenting with views; Use of Presentation techniques; Project work: Application of CAD in developing plans and presentation details of any one residential and commercial building; End term assessment.

**RMCS-512 INTERIOR DESIGN BUSINESS MANAGEMENT 1+2 Sem. II**

**Unit I** Introduction to professional management

Definition of a profession; Principles of interior design business management; Ethics and professional conduct; Establishing interior design practice.

**Unit II** Professional components of managing interior work

Legal issues of business; Business management applications; Marketing; Scale of professional fee and charges; Duties of employer under labour welfare provisions; Structure of interior designers office; Conditions of engagement; Risk management.

**Unit III** Estimating and costing for interior work

Definition; Importance and types of estimation; Units and mode of measurement; Rate analysis; Bills of quantities; Contract design.

**Unit IV** Professional practice

Professional portfolios; Resumes and business cards; Web page and e-service; Professional associations and support systems.

**Practical** : Case study of an established interior design firm; Cost estimation for projects ; Contracting and sub-contracting procedure for the estimated projects; Strategic plan for presentation of project for a tender call; Working on modalities for establishing an interior design firm Preparation of financial plan for a design firm; Working on portfolio and resume design for job in professional firm ; Working with an interior designer for work experience; End term assessment.

**RMCS-513 ENVIRONMENTAL RESOURCE MANAGEMENT 1+1 Sem. I**

**Unit I** General perspectives

Man, environment and economic growth; Industrialization; Urbanization; Consumerism and environment; Environmental informatics; Environment and bio-technology; Environmental ethics.

**Unit II** Ecology, environment and sustainability

Ecological environment and sustainability; Environmental dimensions of sustainable development; Equitable use of resources for sustainable development; Economical, political and cultural influences in the use of environmental resources; Role of government and non-government organizations and communities in sustainable development.

**Unit III** Environmental waste management

Waste management; Waste management systems in India; Technologies for waste management; Hazardous waste management and treatment; Physical and chemical treatment; Thermal treatment and biological treatment; Hazardous waste treatment; E-Waste; Management of E-waste; Inventory management; Production process modification; Volume reduction; Recovery and reuse; Laws and regulations concerning waste management in India.

**Unit IV** Energy and environment

Energy and environment; Economic growth and energy consumption; Increased energy consumption and climate change; Energy policy of India; Energy and sustainability; Sustainable energy resources.

**Unit V** Environmental protection and management

Environmental economics- Concepts, evolution and its development; Important processes and technologies; Environmental protection and management; Environmental quality objectives and standards; Approaches with regard to environmental protection; Institutional and policy framework; Ministry of environment and forest, Pollution control boards.

**Practical** : Understanding the impact of urbanization and consumerism on resource utilization- Literature search; Report preparation on impact of urbanization and consumerism on resource utilization; Presentation and discussion on impact of urbanization and consumerism on resource utilizationVisit to any one industry to understand the types of wastes generated and their waste management practices; Presentation and group discussion; Plan awareness programme to educate college students on their role in environmental protection; Organizing awareness camp; Project work: Household waste management practices among families- ; Planning the research methodology ; Designing data collection tool for collecting information on household waste management practices among families; Finalization of tool; Data collection; Data analysis; Report preparation on household waste management practices among families on household waste management practices among families; Presentation and Group discussion; End term assessment.

**RMCS-514 Special Project** **0+2** **Sem. II**

**RMCS-591 Seminar** **1+0**

**RMCS-599 Master's Research** **0+30**

**Ph.D Courses**

**RMCS-601 Trends in Resource Management** **3+0** **Sem. I**

**Unit I** Significance and scope of family resource management Introduction and history of family resource management and household trends; Resource management as a process; Influences on management styles; Life management for singles, families, households and non family households; Advances in the discipline of resource management.

**Unit II** History and theories of resource management

Managerial practices and concepts from ancient civilization; Early years of family resource management; Household production and consumption systems during pre modern, modern and post modern periods; Theories in resource management; Pre scientific and post scientific approach; Human and non human resource management; Systems Theory;Application of systems Theory to households; Economic Theory; Human ecology and ecosystems; Contemporary management practices.

**Unit III** Managerial competencies

Conflict Management- Concepts, types, sources and levels of conflict; Conflict resolution strategies; Conflict management; Behavioural interventions for handling conflicts; Leadership; Theories of leadership; Types of leadership; Likert's four systems of leadership and managerial grid.

**Unit IV** Management of resources

Managing time as a resource; Modern tools and techniques of time management; Qualitative and quantitative time measures; Legislations, policies and research in family management.

**Unit V** Organizational behaviour

Organizational culture- Concepts, process and implications of organizational culture; Organizational performance-Concept and process, measures for organizational performance, controlling for organizational performance; Overview of control techniques (Scheduling, CPM, PERT, SWOT analysis etc.);Effective control systems; Performance appraisal-Purpose, methods, essentials of good appraisal system; Organizational change- Concepts and nature; Kurt Lewin Theory of change; Implementing change; Managing resistance to change.

**Unit VI** Managerial ethics and social responsibilities

Managerial ethics- Factors affecting ethical choices; Ethical dilemma; Social responsibility- Concept and approaches; Evaluating institutional social performance; Managing institutional ethics and social responsibility.

**RMCS-602 Occupational Biomechanics** **2+1** **Sem. I**

**Unit I** Biomechanical concepts

Biomechanics as an area of study; The biomechanics of the human skeletal articulations; The biomechanics of human skeletal muscle; Application of biomechanics to movement- Qualitative and quantitative approach.

**Unit II** Biomechanics of the human body

The biomechanics of the human upper extremity- Shoulder, elbow wrist and hand; The biomechanics of the human lower extremity- Hip, knee, ankle and foot; The biomechanicsof the human spine.

**Unit III** Occupational biomechanics

Biomechanical oriented ergonomics in workplace; Activity-related soft tissue disorders (ASTDs); Work-related risk factors; Definition and ergonomic guidelines for controlling risk factors; Risk for back injuries in the workplace; Analysis and ergonomic guidelines for controlling.

**Unit IV** Ergonomic task analysis and risk assessment

Ergonomic task analysis- Definition, importance and process; Occupational risk factors; Tools and techniques for identifying posture related risk factors; Tools and techniques for identifying risk factors related to forceful exertion; Tools and techniques for identifying risk factors related repetitive motion; Tools and techniques for identifying risk factors related workstation design; Tools and techniques for identifying risk factors related workplace environment; Ergonomic check points; Development of ergonomic checkpoints for various occupations.

**Unit V** Application of biomechanics

Application of biomechanics for occupational safety; Use of SAMMIE (System for Aiding Man Machine Interaction Evaluation) and CAD system in occupational designs.

**Practical** : Assessing postural risks in a computer workstation; Designing ergonomic guidelines to overcome postural risks; Designing a tool to identify hazards in construction work ; Collection of data on hazards in construction work ; Preparation of report on hazards in construction work Presentation of report and group discussion; Identification of hazards in agricultural operations-Field level observation; Preparation of schedule for identification of hazards in agricultural operations; Data collection on hazards in agricultural operations; Preparation of report on hazards in agricultural operations; Presentation of report and group discussion; Designing ergonomic guidelines for risk elimination; Measuring occupational stress using a standardized tool; Collection of data on occupational stress; Preparation and presentation of report on occupational stress; End term assessment.

**RMCS-603 Globalization and Consumer Economics** **2+1** **Sem. II**

**Unit I** The ontology of consumer economics

Consumer motivation- Concept, components of motivation; Maslow's motivational Theory and consumer behaviour; Consumer decision process- Problem or need recognition, information search, evaluation of alternatives, purchase decision, post-purchase decision; Models of buyer decision making -Economic model, psychological models, consumer behaviour models; Influence of purchase decision- External and internal; Consumer decision styles; Risk in consumer behavior -Functional risk, physical risk, financial risk,social risk, psychological risk, time risk; Adoption and diffusion of innovations; Impulse buying- Definition and types; Factors influencing impulse buying behavior -Consumer related factors, Situational characteristics, product characteristics, store related factors, consumer behaviour.

**Unit II** Global markets

Definition and importance; Features of global marketing; Forces affecting global marketing; Objectives of global marketing; Global marketing environment; Global marketing strategies; Difference between global and international market; Advantages and disadvantages of global marketing.

**Unit III** New economic policies

Introduction to new economic policies- Liberalization, privatization, globalization; Privatization-Introduction, objectives; Types of privatization; Problems of privatization; Privatization in India; Privatization and

global impact; Globalization-Meaning, trends,factors influencing globalization; Impact of globalization on Indian economy; Positive and negative impact of globalization in India; World Trade Organization(WTO) –Objectives and functions; WTO agreement; Benefits of WTO; WTO and developing countries; WTO agreement on agriculture and subsidies; General Agreement on Tariff and Trade (GATT)- Purpose, implications of GATT agreement in various areas.

**Unit IV** The services

Consumer services; Service providers and their obligations towards consumers; Citizen Charter- Vision, mission objectives, importance in public administration; Goods and Service Tax (GST)- Components of GST, benefits of GST, impact of GST on consumers.

**Unit V** Agriculture and Indian economy

Indian agriculture policy; Agriculture credit in India; National agricultural insurance schemes; Agriculture marketing in India; Sustainable agriculture and food security in India; Government programmes for increasing family food security and financial security of consumers.

**Practical :** Project work: Study on impulse buying behaviour among teenage consumers- collection of review; Formulation of objectives for the study; Finalization of method of research; Designing a data collection tool; Data collection on impulse buying behaviour among teenage consumers ; Data analysis and report writing; Presentation of report on impulse buying behaviour among teenage consumers; Presentation of the report on impulse buying behaviour among teenage consumers; Critical analysis of citizen charter of electricity department ; Study the crop insurance scheme ; Conduct farmer awareness camp on crop insurance scheme; Study the implementation of any one government programme for increasing family food security and financial security; Identify structural and functional aspects of any one agriculture market; Observe the functioning of selectedagriculture market. Group discussion on functional aspects of agriculture market; End term assessment.

**RMCS-604 Space Designing and Managerial Dimensions for Special Needs 1+2 Sem. I**

**Unit I** Introduction to interiors for special needs

Types of disabilities and their needs; Barriers in residential and commercial buildings; Theoretical perspectives on efficiency; Comfort and safety; Physical environment; Architectural dimensions- Flooring, stairs, storage, workstations, furniture, fixtures, fitments and equipment.

**Unit II** Universal design

Adapted; Adaptable; Barrier free; Accessible and Universal design-Meaning, differences and features; Principles to be followed in residential and commercial buildings; Suitability of elements and principles of design- Lighting, colours, textures, arrangement of furnishings, floor coverings, window placement etc. for people with special needs.

**Unit III** Managerial dimensions

Managerial dimensions with special reference to time, money and energy for people with special needs; Managerial dimensions with special reference to food and health for people with special needs; External environment support systems for people with special needs; Guidelines for support systems.

**Unit IV** Policies and institutional support

Policies and institutional support for people with special needs; Legal provisions; Access standards and regulations; Physical amenities to be provided for people with special needs; Qualities; Roles and responsibilities of special care managers.

**Practical** : Identifying the existing barriers and accessibility features provided in residential buildings for people with special needs – Preparation of check list, Data collection, Presentation and group discussion, Identifying the existing barriers and accessibility features provided in commercial buildings for people with special needs -Preparation of check list, Data collection,Presentation and group discussion, Design and development of scale model for residential and commercials buildings for visually impaired people – Preparation of conceptual drawings Design and development of scale model for residential and commercials buildings for visually impaired people – Preparation floor plan, elevation, Design and development of scale model for residential and commercials buildings for visually impaired people –

Preparation of landscape plans, Design and development of scale model for residential and commercials buildings for visually impaired people – Preparation of scale model, Presentation and discussion; Design and development of scale model for residential and commercials buildings for hearing impaired people - Preparation of conceptual drawings ; Design and development of scale model for residential and commercials buildings for hearing impaired people - Preparation of floor plan, elevation; Design and development of a scale model for residential and commercials buildings for hearing impaired people - Preparation of landscape plans, ; Design and development of a scale model for residential and commercials buildings for hearing impaired people Preparation of scale model; Presentation and discussion; Design and development of a scale model for residential and commercials buildings for physically challenged people Preparation of conceptual drawings ; Design and development of a scale model for residential and commercials buildings for physically challenged people - Preparation of floor plan, elevation; Design and development of a scale model for residential and commercials buildings for physically challenged people - Preparation of d landscape plans, Design and development of a scale model for residential and commercials buildings for physically challenged people - Preparation of scale model; Presentation and discussion; Visit to old age homes – Preparation of observation tool; Collection of data on living conditions in old age homes; Presentation of information and group discussion; Visit to schools for children with special needs ; Collecting and presenting the information on living conditions in the school; Design and development of a scale model of an old age home with universal design features - Preparation of conceptual drawings ; Design and development of a scale model of an old age home with universal design features - Preparation of floor plan, elevation ; Design and development of a scale model of an old age home with universal design features - Preparation of landscape plans; Design and development of a scale model of an old age home with universal design features - Preparation of scale model; Presentation and group discussion; End term assessment.

**RMCS-605 Physical Ergonomics** **1+2** **Sem. II**

**Unit I** Workplace hazards

Workplace hazards; Types, sources and classification; Hazard identification through interactive exercises; Employee survey methods; Injury log assessment; Hazard control methods.

**Unit II** Work related musculoskeletal disorders

Workplace risk factors and evidence for work relatedness -Posture, force, repetition, vibration, contact stress, environment; Upper limb disorders-Tenosynovitis, Carpal Tunnel Syndrome (CTS) and Tennis elbow, Repetitive Strain Injuries (RSI); Lower limb disorders- Osteoarthritis, Knee bursitis, Meniscal lesions, Stress reaction injuries, Varicose veins.

**Unit III** Ergonomic guidelines for occupational health

Ergonomic program for best practices in work place and hazard reduction; Methods for integrating ergonomics into existing occupations; Workplace evaluation; Risk factor checklists; Hazard reduction-Engineering control, administrative controls.

**Unit IV** Systems approach to ergonomics

Organizational aspects of the human; Work interface to enhance safety; Designing work with systematic procedures to enhance safety; Safety and ergonomics culture.

**Unit V** Digital human model for ergonomic analysis

Virtual ergonomics and its advantage; Introduction to digital human modeling and simulation; Techniques of virtual ergonomics evaluation using digital human modeling.

**Practical :** Identifying common hazards in a selected manufacturing industry through literature search**;** Developing a check list for identifying hazards in a selected manufacturing industry**;** Contentvalidation of the check list**;** Pretesting of check list**;** Establishing the reliability**;** Collection of data on hazards in a selected manufacturing industry**;** Data analysis for identification of occupational hazards**;** Preparation of report on hazards in a selected manufacturing industry; Identification of ergonomic best practices through literature search to safe guard occupational health in manufacturing industry. Planning ergonomic intervention

programme; Implementations of ergonomic interventions in the manufacturing industry; Collection of feedback on effectiveness of ergonomic interventions; Preparation of report; Presentation of report and group discussion; End term assessment.

**RMCS-606 Environmental Issues And Challenges** **2+0** **Sem. I**

**Unit I** Technology and environment

Technology, environment and sustainable development; Positive and negative effect of technological advancement; Effect of technology on organisms and their habitat; Impact of industrialization on environment; Environmental consequences of agricultural development; Environmental effects of information and communication technologies.

**Unit II** Global environmental issues

Global environmental issues; Challenges in building governance mechanism; Efforts at international forums; Climate change and global warming; Conservation of biodiversity and wildlife; Over population and land degradation; Exploitation of natural resourcesand energy crisis; Depletion of ozone layer; Acid rain; Nuclear power; Oil spill pollution; Dumping of hazardous waste.

**Unit III** Environmental management system

Environmental management system; Carbon credits a market based instrument for environmental benefit; Objectives and functioning of national and international organizations in environment conservation; Environmental standards in India; Environmental management approaches; Environment audit; Methodology for environment impact assessment; Environment education.

**Unit IV** Environment and human health

The effect of global environmental change on vector-borne diseases and parasites; Health effects of particulate matter in environment; Human health implications of exposure to chemical residues in the environment; Neuro toxic effects of environmental contaminants on human health; Environmental factors influencing puberty onset; Cancer risk correlated to environment, diet and genetic factors, food and fertility; Climate change and Infectious diseases; Environmental health hazards in various occupations.

**RMCS-607 Family Dynamics and Women Power** **2+1** **Sem. II**

**Unit I** Women and family

Role analysis of Indian home makers during ancient period, medieval period and modern times; Impact of change in the role of women on the family system; Roles and responsibilities of women in various spheres of life; Causes of change in women's role in family and its impact on the family.

**Unit II** Family dynamics

Understanding family dynamics; Family dynamics and its influences on family; Theoretical and conceptual framework to study family dynamics; Institutional norms of family; Family structure; Family ecology and family life development programmes; Economic and psychological cost of gainful employment of women in the family.

**Unit III** Family stress management

Family stress- Meaning, sources and symptoms, causes, effects and consequences of stress; Stress and burnout - Definition of burnout, Difference between stress and burnout, Major signs of burnout; Stress and coping strategies; Types of coping strategies- Appraisal focused, problem focused, emotion focused, occupation focused; Work stress-Sources, consequences and coping strategies; Social support systems for facilitating women's work participation in family and society; Quantitative methods for measuring the perception of stress.

**Unit IV** Women and Law

Status of women in Indian; Women in family; Women and education; Women reservation; Women's economic social and cultural rights; Constitutional provisions and privileges for women in India; Special initiatives for women- National commission for women, reservation for women in local self-government, the national plan of action for the girl child(1991-2000); National policy for the empowerment of

women,2001; Indian laws for the protection of women's rights against domestic violence; Women's economic empowerment and the changing world of women work; International initiatives for women's economic empowerment; United nation's bodies for women's rights; Women in the workforce- Organized and unorganized sectors; Women and occupational health and safety; Provisions for health and safety under occupational health laws in India.

**Practical** : Analysis of aspects of family dynamics in different stages of family life cycle through case study; Report presentation and discussion; Evaluate implementation of any one government programme/ scheme through survey-Formulation of guidelines; Evaluate implementation of any one government programme/scheme through survey-Field survey; Evaluate implementation of any one government programme/scheme through survey-Preparation of report; Report presentation and discussion; Finding out awareness about constitutional provisions and welfare schemes for women-Preparation of data collection tool. Finding out awareness about constitutional provisions and welfare schemes for women-Data collection, Finding out awareness about constitutional provisions and welfare schemes for women-Data analysis Finding out awareness about constitutional provisions and welfare schemes for women-Report writing, Report presentation and discussion; Review of stress measuring tools and techniques-Collection of literature; Presentation on stress measuring tools and techniques; Group discussion on stress measuring tools and techniques Proposing modifications for refinement of tool; End term assessment.

**RMCS-608 Special Project** **0+2** **Sem. II**

**RMCS-691 Seminar I** **1+0**

**RMCS-692 Seminar II** **1+0**

**RMCS-699 Ph.D. Research** **0+75**

**Certificate Course in Interior Design and Decoration (1 year)**

**RMCS 51 Fundamentals of Art and Interior Enrichment** **3(2+1)** **Sem. I**

Introduction and objectives of interior decoration. Elements of art and their importance in interior decoration: line, form, colour, texture and pattern. Principles of design and their application to enrich the interiors: harmony, proportion, rhythm, emphasis and balance. Selection of furniture and furniture arrangement. Classification of wall finishes. Importance, types of floor & floor coverings. Selection, care and maintenance of floor coverings. Functional and decorative window treatments. Selection and types of furnishings. Selection and types of accessories, basic principles of arranging different kind of accessories.

**Practical :** Development of motif and design by using art elements and principles. Colour schemes, hue, value and intensity scale. Drawing of colour wheel. Arrangement of furniture in different areas. Preparation of soft window treatment. Market survey regarding different types of wall, floor coverings and accessories.

**RMCS 52 Housing and Space Management** **3(2+1)** **Sem. I**

Importance and characteristics of good housing system. Housing needs at different stages of family life cycle. Building Codes and standards. Factors to be considered in the selection of housing site. Advantages and disadvantages of renting and owning a house. Types of various house plans. Principles of space management according to functional needs. Building services: wiring, plumbing and sanitation. Construction features in terms of safety, damp proofing, fire proofing, termite proofing and sound proofing. Technologies in house design construction. Low cost building technologies. Low cost building materials.

**Practical :** Drawing of architectural symbols and floor plans on paper. Planning of space management for different areas in the home. Different types of kitchens designs. Space saving storage solutions for various areas of the house. House plans for renovation according to occupants' needs. Market survey to study the available building materials in the local market.

**RMCS 53 Walls and Ceilings : Styles & Finishes** **3(2+1)** **Sem. I**

Types and elements of wall construction. Exterior and interior wall finishing materials. Different types of paints, their care and maintenance. Painting techniques used for wall treatment. Different types of wall papers, wall stickers; their advantages, disadvantages, care and maintenance. Various types of ceilings. Factors influencing choice of wall and ceiling treatments. Solution for wall and ceiling related problems of interiors with application of art elements and design principles.

**Practical :** Market survey for various types of wall and ceiling construction material and finishes Wall and ceiling treatment for congenial environment. Preparation of stickers and stencils for wall decoration.

**RMCS 54 Furniture Design and Arrangement** **3(2+1)** **Sem. I**

Furniture style in different periods. Materials used for furniture fabrication. Upholstered furniture.Factors affecting selection of furniture. Quality of construction. Types of furniture and their selection - tables, desks, seating furniture, sleeping furniture and storage furniture. Furniture arrangement for various rooms and occasions. Cost estimation of furniture for different income groups and areas. Space saving, multipurpose and modular furniture.

**Practical :** Design evaluation of furniture for various activities. Arrangement of furniture for various occasions and different income groups on scale drawing. Market survey for latest trends in furniture design. Sketch drawing of furniture items for different users. Care and cleaning of different types of furniture.

**RMCS 55 Windows and Window Treatments** **3(2+1)** **Sem. II**

Various terminologies used in windows and window treatments. Importance, purpose and types of windows and window treatments. Factors influencing choice of window treatments. Types and styles of curtains and drapes. Fabric and accessories selection for curtains and draperies. Various types of curtain headings. Energy efficient windows. Curtain accessories. Curtains for different rooms. Thermal curtains. Selecting curtain length. Functional considerations for deciding window treatments.

**Practical :** Market survey for availability of various types of curtain materials and hanging systems and their cost analysis. Collecting and making of samples of various types of curtains by using different materials. Planning window dressings and their treatment. Elements and principles of design in windows. Window treatments for congenial environment.

**RMCS 56 Computer Applications in Interior Designing** **2(0+2)** **Sem. II**

**Practical :** Preparation of room plans and layouts on computer. Furniture arrangement in various rooms with the help of software packages. Preparation of house plants/layouts for one bedroom house, two bedroom house and three bedroom house. Colour schemes for different rooms. Placement and arrangement of wall hangings and other accessories. Preparing lighting plans for different rooms.

**RMCS 57 Residential and Commercial Space Designing** **3(2+1)** **Sem. II**

**(In collaboration with Department of Civil Engineering, PAU, Ludhiana)**

Importance of residential and commercial space design, types of residential buildings. Types of commercial buildings. Concepts of functional space designing and their principles. Factors affecting selection of building and finishing materials. Practical consideration of space designing for people with different needs.

**Practical :** Plans of various residential buildings - single storey, multi storey, bungalow, duplex, detached and semi detached. Planning various spaces - drawing room, dining room, lobby, bedroom, storage, kitchen, toilet, dressing and *pooja* room. Planning commercial spaces – Creche & restaurant. Functional designing of storage and cabinets. Elevations of residential buildings. Visits to residential and commercial construction site.

**RMCS 58 Floor and Floor Coverings** **3(2+1)** **Sem. II**

Definition, importance, types and functional considerations of floor and floor coverings. Selection of hard and resilient floor materials. Soft floor coverings. Types, care and maintenance of floor and floor

treatments. Pre-treatment and storage techniques of various types of floor coverings. Decoration of floors by using different media.

**Practical :** Market survey for various types of floor materials and floor coverings. Project work on traditional and contemporary floor treatments. Floor decoration. Care of floor coverings. Eco friendly cleaning techniques for floors and floor coverings. Project work on low cost floor materials.

**RMCS 59 Colour and Lighting in Interiors** **(2+1)** **Sem. II**

Importance of colour and light in interior environment. Properties of colour: hue, value and intensity. Approaches and theories of colour. Types of colour schemes and their effects. Factors to consider while choosing colour schemes for various places. Use and application of colour in interiors of residential and non-residential buildings. Importance and sources of lighting. Decorative aspects of lighting, types of lighting and lighting requirements for various household activities. Use of colour and lighting in problematic areas of the house.

**Practical :** Planning colour schemes for residential interiors. Effect of different types of lighting in interior spaces. Suitable lighting fixtures for residential and commercial buildings. Preparation of colour and lighting plans for different problematic areas of the house. Market survey regarding availability of latest trends of lighting system and accessories.

**RMCS 60 Special Project** **4(0+4)** **Sem. II**

# COURSE CURRICULUM FOR B.Sc. (Hons.) COMMUNITY SCIENCE
# 4-YEAR PROGRAMME AFTER 10+2

## BASIC COURSES

### A. Deficiency Courses (Non-Creditable)

a) For students from Non-Medical stream

| | | | |
|---|---|---|---|
| 1. | Bio. 102 | Introductory Biology | 1+1 |
| | | Total | 1+1 |

b) For students from Medical stream

| | | | |
|---|---|---|---|
| 1. | Math. 106 | Introductory Mathematics | 2+0 |
| | | Total | 2+0 |

c) For students who have not studied Punjabi upto Matric or +2 level

| | | | |
|---|---|---|---|
| 1. | Pbi. 101 | Basic Punjabi | 0+2 |
| | | Total | 0+2 |

d) For ICAR Nominees / Foreign students

| | | | |
|---|---|---|---|
| 1. | Pbi. Cul. 101 | Punjabi Culture | 2+0 |
| | | Total | 2+0 |

### (B) REQUIRED COURSES

**I Basic Sciences and Humanities**

| | | |
|---|---|---|
| Zoo. 103 | Elementary Human Physiology | 2+1 |
| Soc.102 | Introduction to Rural Sociology | 2+0 |
| Biochem. 104 | Principles of Biochemistry | 2+1 |
| Eng. 101 | General English | 1+1 |
| Eng. 201 | Communication Skills and Personality Development | 1+1 |
| Econ.201 | Economics and Marketing | 2+1 |
| Mgt.201 | Entrepreneurship Development and Business Management | 2+1 |
| Micro.207 | Principles of Food Microbiology | 2+1 |
| Stat. 207 | Principles of Statistics | 2+1 |
| | Total: | 16+8 |

**II Agriculture**

| | | |
|---|---|---|
| Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| | Total: | 2+0 |

**III Agricultural Engineering and Technology**

| | | |
|---|---|---|
| CSE 101 | Information & Communication Technology in Agriculture | 1+2 |
| | Total: | 1+2 |

## IV. Home Science

A. CORE Courses

| | | | |
|---|---|---|---|
| ATS 101 | Fundamentals of Clothing Construction | 1+2 | Sem. I |
| ATS 102 | Textile Science and Fabric Care | 2+1 | Sem. II |
| ATS 201 | Techniques of Fabric Construction | 2+1 | Sem. I |
| ATS 202 | Garment and Accessory Designing | 0+3 | Sem. II |
| ATS 301 | Textile Finishes | 2+1 | Sem. I |
| ATS 302 | Traditional Textiles of India | 2+1 | Sem II |
| ATS 303 | Retailing and Merchandising- Textiles and Apparel | 2+0 | Sem II |
| EECM 101 | Extension Education and Rural Development | 3+0 | Sem. I |
| EECM 102 | Diffusion and Adoption of Homestead Technologies | 2+1 | Sem. II |
| EECM 201 | Women in Agriculture | 2+0 | Sem. I |
| EECM 202 | Instructional Technology | 1+2 | Sem. II |
| EECM 301 | Extension Training Management | 1+2 | Sem. I |
| EECM 302 | Programme Development for Rural Families | 1+2 | Sem. II |
| FRM 101 | Management of Resources and System Dynamics | 1+1 | Sem. I |
| FRM 102 | Housing and Space management | 2+1 | Sem. II |
| FRM 201 | Fundamentals of Art and Interior Enrichment | 1+3 | Sem. I |
| FRM 202 | Ergonomics in Household and Farm Technologies | 1+2 | Sem. II |
| FRM 301 | Family Finance and Consumer Education | 2+0 | Sem. I |
| FRM 302 | Residential and Commercial Space Designing | 2+1 | Sem.II |
| FN 101/ N Diet. 101/ FND 101 | Principles of Human Nutrition | 3+0 | Sem. I |
| FN 102 | Fundamentals of Food Science and Processing | 2+1 | Sem. II |
| FN 201 | Normal and Therapeutic Nutrition | 2+1 | Sem. I |
| FN 202 | Food & Nutrition Policy and Agriculture | 2+0 | Sem. I |
| FN 203 | Community Nutrition and Education | 2+1 | Sem. II |
| FN204 | Clinical Nutrition and Dietetics | 2+1 | Sem. II |
| FN301 | Fundamentals of Food Hygiene and Sanitation | 1+1 | Sem. I |
| FN 302 | Home Scale Food Preservation | 1+1 | Sem. I |
| FN 303 | Food Standards and Quality Control | 2+1 | Sem. II |
| FN 304 | Food Analysis | 2+1 | Sem. II |
| FN 305 | Bakery and Confectionary | 0+2 | Sem. II |
| HDFS 101 | Fundamentals of Human Development | 2+0 | Sem. I |
| HDFS 106 | Human Values | 1+0 | Sem. I, II |
| HDFS 102 | Childhood and Adolescence | 2+1 | Sem. II |
| HDFS103 | Adulthood and Ageing | 2+0 | Sem. II |
| HDFS 201 | Marriage and Family Dynamics | 2+1 | Sem. I |
| HDFS 202 | Developmental Challenges in Children | 2+1 | Sem. II |
| HDFS 301 | Family Counselling and Child Welfare | 2+1 | Sem. I |
| HDFS 302 | Educational Psychology and Early Childhood Education | 2+1 | Sem. II |
| | **Total** | **103(64+39)** | |

**Total Credit Hour Requirements of B.Sc. (Hons.) Community Science 4-Year Programme**

| | | |
|---|---|---|
| a) | For students coming from Medical Stream without Punjabi | 182 |
| b) | For students coming from Medical Stream with Punjabi | 180 |
| c) | For students coming from Non-Medical Stream without Punjabi | 182 |
| d) | For students coming from Non-Medical Stream with Punjabi | 180 |
| e) | For ICAR Nominees / Foreign students from Medical Stream | 182 |
| f) | For ICAR Nominees / Foreign students from Non-Medical Stream | 182 |

**Areas of Specialization in various Elective Programmes and package of courses for each**

**Apparel and Textile Science**

**(Apparel Manufacturing)**

| | | | |
|---|---|---|---|
| **ATS 401** | **Seminar** | **1+0** | **Sem. I** |
| ATS 402 | Experiential Learning-I Computer Aided Designing and Pattern Making | | |
| ATS 403 | Experiential Learning-II Manufacturing of Lifestyle Products | 0+12 | Sem. I |
| ATS 412 | Internship-I Entrepreneurial Placement/ Inplant Training | 0+8 | Sem. II |
| ATS 413 | Internship - II Project Report and Presentation | 0+2 | Sem. II |

**2. Extension Education and Communication Management**

(Programme development and Entrepreneurship)

| | | | |
|---|---|---|---|
| EECM 401 | Seminar | 1+0 | Sem. I |
| EECM 402 | Instructional Video Production | 0+9 | Sem. I |
| EECM 403 | Public Relation and Social Marketing | 0+2 | Sem. I |
| EECM 404 | Web Designing and Multimedia Production | 0+9 | Sem. I |
| EECM 411 | Rural Awareness Work Experience (RAWE) | 0+10 | Sem. II |
| EECM 412 | Internship I -Entrepreneurial Placement/In Plant Training | 0+8 | Sem. II |
| EECM 413 | Internship II Project Report and Presentation | 0+2 | Sem. II |

**3. Food & Nutrition**

(Nutrition and Dietetics/ Food Nutrition and Dietetics)

| | | | |
|---|---|---|---|
| FN 401 | Seminar | 1+0 | Sem. I |
| FN 402 | Experiential Learning I - Bakery and Confectionary | 0+8 | Sem. I |
| FN 403 | Experiential Learning II - Bakery and Confectionary | 0+12 | Sem. I |
| FN 412 | Internship-I Entrepreneurial Placement/ Inplant Training | 0+8 | Sem. II |
| FN 413 | Internship-II Project Report and Presentation | 0+2 | Sem. II |

**4. Human Development and Family Studies**

(Organization and Management of ECCE Programme)

| | | | |
|---|---|---|---|
| HDFS 401 | Seminar | 1+0 | Sem. I |
| HDFS 402 | Experiential Learning-I Early Childhood Care and Education | 0+8 | Sem. I |
| HDFS 403 | Experiential Learning-II Early Childhood Care and Education | 0+12 | Sem. I |
| HDFS 412 | Internship-I Entrepreneurial Placement/In plant Training | 0+8 | Sem. II |
| HDFS 413 | Internship-II Project Report and Presentation | 0+2 | Sem. II |

**5. Resource Management and Consumer Science**

(Artistic Creations)

| | | | |
|---|---|---|---|
| FRM 401 | Seminar | 1+0 | Sem. I |
| FRM 402 | Experiential Learning I -Art Creations | 0+8 | Sem. I |
| FRM 403 | Experiential Learning II -Marketing Management of Art Creations | 0+12 | Sem. I |
| FRM 412 | Internship I - Entrepreneurial Placement/In plant Training | 0+8 | Sem. II |
| FRM 413 | Internship II - Project Report and Presentation | 0+2 | Sem. II |

# SEMESTER-WISE STUDY PROGRAMME OF B.Sc. (Hons.) COMMUNITY SCIENCE 4 YEAR DEGREE PROGRAMME

**1st year**

| 1st Semester | | | 2nd Semester | | |
|---|---|---|---|---|---|
| ATS 101 | Fundamentals of Clothing Construction | 3(1+2) | ATS 102 | Textile Science and Fabric Care | 3(2+1) |
| FN 101 | Principles of Human Nutrition | 3(3+0) | FN 102 | Fundamentals of Food Science and Processing | 3(2+1) |
| FRM 101 | Management of Resources and System Dynamics | 2(1+1) | FRM 102 | Housing and Space Management | 3(2+1) |
| EECM 101 | Extension Education and Rural Development | 3(3+0) | HDFS 102 | Childhood and Adolescence | 3(2+1) |
| HDFS 101 | Fundamentals of Human Development | 2(2+0) | HDFS 103 | Adulthood and Aging | 2(2+0) |
| CSE 101 | Information & Communication Technology in Agriculture | 3(1+2) | EECM 102 | Diffusion and Adoption of Homestead Technologies | 3(2+1) |
| Bio. 102*/ Math 106** | Introductory Biology / Introductory Mathematics | 2(1+1)/ 2(2+0) NC | HDFS 106 | Human Values | 1(1+0) |
| Pbi.101 ***/ Pbi. Cul. 101**** | Basic Punjabi / Punjabi Culture | 2(0+2)/ 2(2+0) NC | Biochem. 104 | Principles of Biochemistry | 3(2+1) |
| | | | Eng 101 | General English | 2(1+1) |
| | NSS/NSO/NCC | 1(0+1) NC | | NSS/NSO/NCC | 1(0+1) NC |
| | **TOTAL** | **16(11+5)+ 5*/5**NC** | | **TOTAL** | **23(16+7) +1NC** |

* For students admitted after 10+2 Non-Medical stream

** For students admitted after 10+2 Medical stream

*** For undergraduate students who have not studied Punjabi upto Matric or 10+2 level

**** For ICAR Nominees and for foreign students

**2nd year**

| 1st Semester | | | 2nd Semester | | |
|---|---|---|---|---|---|
| EECM 201 | Women in Agriculture | 2(2+0) | ATS 202 | Garment and Accessory Designing | 3(0+3) |
| ATS 201 | Techniques of Fabric Construction | 3(2+1) | FN 203 | Community Nutrition and Education | 3(2+1) |
| FN 201 | Normal and Therapeutic Nutrition | 3(2+1) | FN 204 | Clinical Nutrition and Dietetics | 3(2+1) |
| FN 202 | Food & Nutrition Policy and Agriculture | 2(2+0) | HDFS 202 | Developmental Challenges in Children | 3(2+1) |
| FRM 201 | Fundamentals of Art and Interior Enrichment | 4(1+3) | EECM 202 | Instructional Technology | 3(1+2) |
| HDFS 201 | Marriage and Family Dynamics | 3(2+1) | FRM 202 | Ergonomics in Household and Farm Technologies | 3(1+2) |
| Micro.207 | Principles of Food Microbiology | 3(2+1) | Mgt. 201 | Entrepreneurship Development and Business Management | 3(2+1) |
| Stat.207 | Principles of Statistics | 3(2+1) | Soc.102 | Introduction to Rural Sociology | 2(2+0) |
| | NSS/NSO/NCC | 1(0+1) NC | | NSS/NSO/NCC | 1(0+1) NC |
| | **TOTAL** | **23 (15+8)+ 1NC** | | **TOTAL** | **23 (12+11) + 1NC** |

**3rd year**

| 1st Semester | | | 2nd Semester | | |
|---|---|---|---|---|---|
| ATS 301 | Textile Finishes | 3(2+1) | ATS 302 | Traditional Textiles of India | 3(2+1) |
| FN 301 | Fundamentals of Food Hygiene and Sanitation | 2(1+1) | ATS 303 | Retailing and Merchandising- Textiles and Apparel | 2(2+0) |
| FN 302 | Home Scale Food Preservation | 2(1+1) | FN 303 | Food Standards and Quality Control | 3(2+1) |
| HDFS 301 | Family Counselling and Child Welfare | 3(2+1) | FN 304 | Food Analysis | 3(2+1) |

| | | | | | |
|---|---|---|---|---|---|
| FRM 301 | Family Finance and Consumer Education | 2(2+0) | FN 305 | Bakery and Confectionary | 2(0+2) |
| EECM 301 | Extension Training Management | 3(1+2) | FRM 302 | Residential and Commercial Space Design | 3(2+1) |
| Zoo.103 | Elementary Human Physiology | 3(2+1) | HDFS 302 | Educational Psychology and Early Childhood Education | 3(2+1) |
| Econ.201 | Economics and Marketing | 3(2+1) | EECM 302 | Programme Development for Rural Families | 3(1+2) |
| Env 101 | Environmental Studies and Disaster Management | 2(2+0) | Eng. 201 | Communication Skills and Personality Development | 2(1+1) |
| | Educational Tour | 1(0+1) NC | | | |
| | **TOTAL** | **23(15+ 8) +1NC** | | **TOTAL** | **24 (14+10)** |

**4th year**

| **1st Semester** | | | **2nd Semester** | | |
|---|---|---|---|---|---|
| 401 | Seminar | 1(1+0) | EECM 411 | Rural Awareness Work Experience | 10(0+10) |
| 402 | Experiential Learning I | 8(0+8) | 412 | Internship-I Entrepreneurial Placement/ In plant Training | 8(0+8) |
| 403 | Experiential Learning II | 12(0+12) | 413 | Internship-II Project Report and Presentation | 2(0+2) |
| | TOTAL | 21(1+20) | | TOTAL | 20(0+20) |

Total Credit Hours = 173+9 NC = 182

List of Deficiency Courses to be offered

| Sr.No. | Course Title | Course No. | Credit Hours |
|---|---|---|---|
| 1. | Introductory Biology* | Bio. 102 | 2(1+1)NC |
| 2. | Introductory Mathematics** | Math. 106 | 2(2+0) NC |
| 3. | Basic Punjabi*** | Pbi. 101 | 2(0+2) NC |
| 4. | Punjabi Culture**** | Pbi.Cul. 101 | 2(2+0)NC |

For students admitted after 10+2 Non-Medical stream

** For students admitted after 10+2 Medical stream

*** For undergraduate students who have not studied Punjabi upto Matric or 10+2 level

**** For ICAR Nominees and for foreign students

## Educational Tour

Visit to Home Science College; large scale Catering or Training Institutes/Hotels (five star), Preservation Units; Textile Mills, NIFT/NITRA/IIT; Ford Foundation Centre/School of Planning and Architecture/National Building Organisation, Furniture Industry; Institute of Mass Communication/ Mass Communication Research Centre, Institute for Non-formal Education.

**1. Total package for B.Sc. (Hons) Community Science- 4 year degree programme:**

| | | |
|---|---|---|
| Basic Courses | 137 | 29 |
| Core Courses | | 103 |
| Specialization/Professional | | 21 |
| Internship | | 10* |
| RAWE | | 10 |
| NSS and Physical Education 04(NC) Educational Tour 01(NC) | NSS/NSO/NCC for 4 Semesters, | |
| Total | | 178 |

# SEMESTER-WISE STUDY PROGRAMME OF B.Sc. (Hons.)
# FASHION DESIGNING 4 YEAR DEGREE PROGRAMME

## (A) REQUIRED COURSES

### I Basic Sciences and Humanities

| | | Cr Hrs |
|---|---|---|
| 1. Eng. 101 | General English | 1+1 |
| 2. Eng. 201 | Communication Skills and Personality Development | 1+1 |
| 3. Mgt. 301 | Fundamentals of Entrepreneurship | 2+0 |
| 4. Mgt. 302 | Accounting and Inventory Management | 2+0 |

### II Community Science

#### a. Apparel and Textile Science

| | | |
|---|---|---|
| 1. FD 101 | Basics of Design Composition | 1+2 |
| 2. FD 102 | Visual Studies and Appreciation | 0+2 |
| 3. FD 103 | Introductory Textiles | 2+1 |
| 4. FD 104 | Introductory Sewing Techniques | 0+3 |
| 5. FD 105 | Dynamics of Fashion | 2+0 |
| 6. FD 106 | Introduction to Apparel Industry | 2+0 |
| 7. FD 107 | Textile Decorations | 0+3 |
| 8. FD 111 | Fashion Drawing- I | 0+2 |
| 9. FD 112 | Fashion Studies | 2+0 |
| 10. FD 113 | Pattern Making and Garment Construction-I | 1+2 |
| 11. FD 114 | Introduction to Knitwear Technology | 1+2 |
| 12. FD 115 | Woven Structures | 1+2 |
| 13. FD 201 | Fashion Drawing- II | 0+3 |
| 14. FD 202 | Merchandising Fashion | 2+2 |
| 15. FD 203 | Traditional Textiles | 2+1 |
| 16. FD 204 | Pattern Making and Garment Construction-II | 0+2 |
| 17. FD 205 | Knitwear Designing | 0+2 |
| 18. FD 206 | Costumes of the World | 2+1 |
| 19. FD 207 | Computer Aided Fashion Illustrations | 0+2 |
| 20. FD 211 | Apparel Production Technology | 1+2 |
| 21. FD 212 | Computer Aided Designing and Pattern Making | 0+4 |
| 22. FD 213 | Draping and Flat Pattern Making | 0+3 |
| 23. FD 214 | Basics of Grading | 0+2 |
| 24. FD 215 | Indian Costumes | 2+1 |
| 25. FD 216 | Garment Production Machinery and Equipment | 1+1 |
| 26. FD 301 | Retail Fashion Merchandising and Marketing | 2+1 |
| 27. FD 302 | Quality Control | 2+2 |
| 28. FD 303 | Commercial Product Designing | 0+3 |

| | | | |
|---|---|---|---|
| 29. | FD 304 | Graphic Design | 0+2 |
| 30. | FD 305 | Dyeing Studies | 1+2 |
| 31. | FD 306 | Textile Printing | 1+2 |
| 32. | FD 307 | Trims and Accessories | 2+0 |
| 33. | FD 311 | Fashion Communication | 1+1 |
| 34. | FD 312 | Sociological, Psychological and Ethical Aspects of Fashion | 2+0 |
| 35. | FD 313 | Apparel Supply Chain Management | 2+0 |
| 36. | FD 314 | Visual Merchandising | 1+1 |
| 37. | FD 315 | Craft Documentation | 2+4 |
| 38. | FD 401 | Green Technologies in Apparel Manufacturing | 2+0 |
| 39. | FD 402 | Experiential Learning in Fashion and Life Style Products | 0+12 |
| 40. | FD 410 | Seminar | 0+2 |
| 41. | FD 411 | Product Line Development / Presentation | 0+6 |
| 42. | FD 419 | Internship-I | 0+12 (NC) |
| 43. | FD 420 | Internship-II | 0+4 |

**b. Extension E ducat i on & Communication Management**

| | | | |
|---|---|---|---|
| 1. | EECM 211 | Interpersonal and Organizational Skills | 2+1 |
| 2. | EECM 312 | Fashion Photography | 1+2 |

**c. Human Development and Family Studies**

**1. HDFS 106 Human Values 1+0**

## III College of Agriculture

**1. Env. 101 Environmental Studies and Disaster Management 2+0**

## IV. College of Agricultural Engineering & Technology

**1. CSE 101 Information and Communication Technology in Agriculture 1+2**

**Total Credit Hours requirement for B.Sc.(Hons) Fashion Designing = 164**

# SEMESTER-WISE STUDY PROGRAMME OF B.Sc. (Hons.) FASHION DESIGNING
# 4 YEAR DEGREE PROGRAMME

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| FD 101 | | 3(1+2) | FD 111 | 2(0+2) |
| FD 102 | | 2(0+2) | FD 112 | 2(2+0) |
| FD 103 | | 3(2+1) | FD 113 | 3(1+2) |
| FD 104 | | 3(0+3) | FD 114 | 3(1+2) |
| FD 105 | | 2(2+0) | FD 115 | 3(1+2) |
| FD 106 | | 2(2+0) | HDFS 106 | 1(1+0) |
| FD 107 | | 3(0+3) | Eng 101 | 2(1+1) |
| NSS/NSO/NCC | | 1(0+1) NC | CSE 101 | 3(1+2) |
| | | | NSS/NSO/NCC | 1(0+1) NC |
| TOTAL | | 18+1 NC=19 | TO TOTAL | 19+1 NC=20 |

| SECOND YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| FD 201 | | 3(0+3) | FD 211 | 3(1+2) |
| FD 202 | | 4(2+2) | FD 212 | 4(0+4) |
| FD 203 | | 3(2+1) | FD 213 | 3(0+3) |
| FD 204 | | 2(0+2) | FD 214 | 2(0+2) |
| FD 205 | | 2(0+2) | FD 215 | 3(2+1) |
| FD 206 | | 3(2+1) | FD 216 | 2(1+1) |
| FD 207 | | 2(0+2) | Eng 201 | 2(1+1) |
| Env 101 | | 2(2+0) | EECM 211 | 3(2+1) |
| NSS/NSO/NCC | | 1(0+1) NC | NSS/NSO/NCC | 1(0+1) NC |
| TOTAL | | 21+1 NC=22 | TOTAL | 22+1 NC=23 |
| **THIRD YEAR** | | | | |
| **SEM I** | | | **SEM II** | |
| FD 301 | | 3(2+1) | FD 311 | 2(1+1) |
| FD 302 | | 4(2+2) | FD 312 | 2(2+0) |
| FD 303 | | 3(0+3) | FD 313 | 2(2+0) |
| FD 304 | | 2(0+2) | FD 314 | 2(1+1) |
| FD 305 | | 3(1+2) | FD 315 | 6(2+4) |
| FD 306 | | 3(1+2) | Mgt 301 | 2(2+0) |
| FD 307 | | 2(2+0) | EECM 312 | 3(1+2) |
| Mgt 302 | | 2(2+0) | | |
| Edu Tour | | 1(0+1) NC | | |
| TOTAL | | 22+1 NC=23 | TOTAL | 19 |

| FOURTH YEAR | | | | |
|---|---|---|---|---|
| SEM I | | | SEM II | |
| FD 401 | | 2(2+0) | FD 411 | 6(0+6) |
| FD 402 | | 12(0+12) | FD 419 | 12)0+12) NC |
| FD 410 | | 2(0+2) | FD 420 | 0+4 |
| TOTAL | | 16 | TOTAL | 22 |

### Educational Tour

Visit to Home Science Colleges; Designer Houses, Export Houses and Buying Houses; Textile units,NIFT/NITRA/NID.

# COURSE CURRICULUM FOR B.Sc. (Hons.) NUTRITION AND DIETETICS / FOOD NUTRITION AND DIETETICS - 4 YEAR PROGRAMME

## Basic Sciences and Humanities

**(a) Deficiency Course (Non Creditable)**

**For students from medical stream**

| | | | |
|---|---|---|---|
| 1. | Math. 106 | Introductory Mathematics | 2 + 0(NC) |

**For students from Non-medical stream**

| | | | |
|---|---|---|---|
| 1. | Bio. 102 | Introductory Biology | 1+1(NC) |

**For undergraduate students who have not studied Punjabi upto Matric or 10+2 level**

| | | | |
|---|---|---|---|
| 1. | Pbi.101 | Basic Punjabi | 0 + 2(NC) |

**For ICAR Nominees / Foreign students**

| | | | |
|---|---|---|---|
| 1. | Pbi. Cult. | Punjabi Culture | 2 + 0(NC) |

## Required courses

| | | |
|---|---|---|
| 1. Zoo. 103 | Elementary Human Physiology | 2+1 |
| 2. Biochem. 102 | Nutritional Biochemistry-I | 2+1 |
| 3. Biochem. 103 | Nutritional Biochemistry-II | 3+0 |
| 4. Eng. 101 | General English | 1+1 |
| 5. Soc. 102 | Introduction to Rural Sociology | 2+0 |
| 6. Eng. 201 | Communication skills and Personality Development | 1+1 |
| 7. Micro. 207 | Principles of Food Microbiology | 2+1 |
| 8. Stat. 207 | Introductory Statistics | 2+1 |
| 9. Econ.201 | Economics and Marketing | 2+1 |
| 10. Mgt. 201 | Entrepreneurship Development and Business management | 2+1 |
| | | 19+8 |

**2. Agriculture**

| | | |
|---|---|---|
| 1. Biotech. 311 | Nutrigenomics | 2+1 |
| 2. Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| | | 4+1 |

**3. Agricultural Engineering**

| | | |
|---|---|---|
| 1. CSE 101 | Information and Communication Technology in Agriculture | 1+2 |
| | | 1+2 |

**4. Home Science**

I Food and Nutrition

| | | |
|---|---|---|
| 1. N Diet. 101/ FND 101/ FN 101 | Principles of Human Nutrition | 3+0 |
| 2. N Diet. 102/ FND 102 | Fundamentals of Food Science | 2+1 |
| 3. N Diet. 103/ FND 103 | Food Hygiene and Sanitation | 2+1 |
| 4. N Diet. 104/ FND 104 | Methods of Cookery | 2+1 |
| 5. N Diet. 105/ FND 105 | Food Processing and Packaging | 2+1 |

| | | |
|---|---|---|
| 6. N Diet.106/ FND 106 | Food Preservation and Storage | 2+1 |
| 7. N Diet. 201/ FND 201 | Normal Nutrition and Meal Planning | 3+1 |
| 8. N Diet. 202/ FND 202 | Nutrition and Immunity | 3+0 |
| 9. N Diet. 203/ FND 203 | Food Product Formulations and Development | 2+1 |
| 10. N Diet. 204/ FND 204 | Cereals, Pulses and Oilseeds: Preparation and Utilization | 2+2 |
| 11. N Diet. 205/ FND 205 | Nutrition through Life Cycle | 2+0 |
| 12. N Diet. 206/ FND 206 | Community Nutrition | 2+2 |
| 13. N Diet. 207/ FND 207 | Public Health Nutrition | 3+1 |
| 14. N Diet. 208/ FND 208 | Introduction to Clinical Nutrition | 2+1 |
| 15. N Diet. 209/ FND 209 | Therapeutic Nutrition-I | 2+2 |
| 16. N Diet. 210/ FND 210 | Fruits and Vegetables: Preparation and Utilization | 2+1 |
| 17. N Diet. 211/ FND 211 | Sports Nutrition and Physical Fitness | 3+0 |
| 18. N Diet. 301/ FND 301 | Therapeutic Nutrition-II | 2+1 |
| 19. N Diet. 302/ FND 302 | Food Chemistry | 3+1 |
| 20. N Diet. 303/ FND 303 | Milk and Milk Products: Preparation and Utilization | 2+1 |
| 21. N Diet. 304/ FND 304 | Food Safety Standards and Quality Assurance | 3+1 |
| 22. N Diet. 305/ FND 305 | Nutrition in Disaster Management | 3+0 |
| 23. N Diet. 306/ FND 306 | Nutritional Strategies in ICU | 2+1 |
| 24. N Diet. 307/ FND 307 | Fundamentals of Nutraceuticals and Health Foods | 3+0 |
| 25. N Diet. 308/ FND 308 | Food Service Management | 1+2 |
| 26. N Diet. 309/ FND 309 | Drug Nutrient Interaction | 2+0 |
| 27. N Diet. 310/ FND 310 | Food Toxicology | 2+0 |
| 28. N Diet. 311/ FND 311 | Meat and Meat Products: Preparation and Utilization | 2+1 |
| 29. N Diet. 312/ FND 312 | Food Analysis | 3+1 |
| 30. N Diet. 313/ FND 313 | Fundamentals of bakery and Confectionary | 2+2 |
| 31. N Diet. 401/ FND 401 | In-Plant Training | 0+16 |
| 32. N Diet. 402/ FND 402 | Report Writing and Presentation | 0+4 |
| 33. N Diet. 403/ FND 403 | Seminar | 1+0 |
| 34. N Diet. 404/ FND 404 | Experiential Learning-I Diet and Nutrition Counselling | 0+8 |
| 35. N Diet. 405/ FND 405 | Experiential Learning-II Diet and Nutrition Counselling | 0+12 |
| | | 70+67 |

## II Human Development and Family Studies

**1. HDFS 106 Human Values** **1+0**

Total Credit Hours requirement of B.Sc. (Hons) Nutrition and Dietetics/ Food Nutrition and Dietetics 4-Year Programme

a) For students coming from Medical Stream 173+2*

b) For students coming from Non-Medical Stream 173+2*

c) For undergraduate students who have not studied Punjabi upto Matric or 10+2 level/ICAR nominees/ Foreign students from Medical Stream 173+4*

d) For undergraduate students who have not studied Punjabi upto Matric or 10+2 level/ICAR nominees/ Foreign students from Non-Medical Stream 173+4*

# SEMESTER-WISE STUDY PROGRAMME FOR B.Sc. (Hons.) NUTRITION AND DIETETICS / FOOD NUTRITION AND DIETETICS - 4 YEAR PROGRAMME

## FIRST YEAR

| SEM I | | SEM II | |
|---|---|---|---|
| N Diet.101/ FND 101/ FN101 | 3(3+0) | N Diet.104/ FND 104 | 3(2+1) |
| N Diet.102/FND 102 | 3(2+1) | N Diet.105/ FND 105 | 3(2+1) |
| N Diet.103/ FND 103 | 3(2+1) | N Diet.106/ FND 106 | 3(2+1) |
| Zoo. 103 | 3(2+1) | Biochem. 103 | 3(3+0) |
| Biochem. 102 | 3(2+1) | Eng. 101 | 2(1+1) |
| Env. 101 | 2(2+0) | Soc. 102 | 2(2+0) |
| Math. 106*/Bio. 102** | 2(2+0) (NC) / 2(1+1)(NC) | HDFS 106 | 1(1+0) |
| Pbi. 101***/Pbi.Cult.**** | 2(0+2) (NC)/ 2(2+0) (NC) | Eng. 201 | 2(1+1) |
| NSS/NSO/NCC | 1(0+1)(NC) | CSE 101 | 3(1+2) |
| | | NSS/NSO/NCC | 1(0+1)(NC) |
| Total | 13+4=17+5NC/3 NC/1NC | Total | 15+7=22+1NC |

## SECOND YEAR

| SEM I | | SEM II | |
|---|---|---|---|
| N Diet. 201/ FND 201 | 4(3+1) | N Diet. 205/ FND 205 | 2(2+0) |
| N Diet. 202/ FND 202 | 3(3+0) | N Diet. 206/FND 206 | 4(2+2) |
| N Diet. 203/ FND 203 | 3(2+1) | N Diet. 207/ FND 207 | 4(3+1) |
| N Diet. 204/ FND 204 | 4(2+2) | N Diet. 208/ FND 208 | 3(2+1) |
| Micro. 207 | 3(2+1) | N Diet. 209/ FND 209 | 4(2+2) |
| Stat. 207 | 3(2+1) | N Diet. 210/ FND 210 | 3(2+1) |
| Econ. 201 | 3(2+1) | N Diet. 211/ FND 211 | 3(3+0) |
| NSS/NSO/NCC | 1(0+1)(NC) | NSS/NSO/NCC | 1(0+1)(NC) |
| Total | 16+7=23+1 NC | Total | 16+7=23+1 NC |

## THIRD YEAR

| SEM I | | SEM II | |
|---|---|---|---|
| N Diet. 301/ FND 301 | 3(2+1) | N Diet. 307/ FND 307 | 3(3+0) |
| N Diet. 302/ FND 302 | 4(3+1) | N Diet. 308/ FND 308 | 3(1+2) |
| N Diet. 303/ FND 303 | 3(2+1) | N Diet. 309/ FND 309 | 2(2+0) |
| N Diet. 304/ FND 304 | 4(3+1) | N Diet. 310/ FND 310 | 2(2+0) |
| N Diet. 305/ FND 305 | 3(3+0) | N Diet. 311/ FND 311 | 3(2+1) |
| N Diet. 306/ FND 306 | 3(2+1) | N Diet. 312/ FND 312 | 4(3+1) |
| Biotech. 311 | 3(2+1) | N Diet. 313/ FND 313 | 4(2+2) |
| Educational Tour | 1(0+1) (NC) | Mgt. 201 | 3(2+1) |
| Total | 17+6=23+1 NC | Total | 17+7=24 |

FOURTH YEAR

| SEM I | | SEM II | |
|---|---|---|---|
| N Diet. 401/ FND 401 | 16(0+16) | N Diet. 403 /FND 403 | 1(1+0) |
| N. Diet. 402/ FND 402 | 4(0+4) | N Diet. 404 / FND 404 | 8(0+8) |
| | | N Diet. 405/ FND 405 | 12(0+12) |
| Total | 0+20=20 | Total | 1+20=21 |

* For students admitted after 10+2 Medical stream

** For students admitted after 10+2 Non- Medical stream

*** For UG students who have not studied Punjabi upto Matric or 10+2 level

****For ICAR nominees and for foreign students

## Educational Tour

Visit to large scale catering institutes/training institutes/hotels (five star)/food craft institutes/Home Science Colleges and Dietary department of various hospitals.

# COURSE CURICULUM FOR 1 YEAR CERTIFICATE COURSE IN EARLY CHILDHOOD CARE AND EDUCATION

**CORE COURSES**

**COLLEGE OF COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1. | HDFS 51 | Personality and Value Education | 1+2 |
| 2. | HDFS 52 | Early Childhood Care and Education | 3+1 |
| 3. | HDFS 53 | Developmental Assessment of Young Children | 2+2 |
| 4. | HDFS 54 | Participation in Early Childhood Care and Education Services | 1+3 |
| 5. | HDFS 55 | Identification and Management of Differently Abled Children | 2+2 |
| 6. | HDFS 56 | Creative Experiences for Young Children | 2+2 |
| 7. | HDFS 57 | Entrepreneurship in Child Care and Education Services | 2+2 |
| 8. | EECM 54 | Empowerment through Life Skills | 1+2 |
| 9. | RMCS 58 | Residential and Commercial Space Designing | 2+1 |
| 10. | EECM 52 | Skills for Effective Communication | 1+2 |
| | | | 17+19 |

**Total Credit hour requirement for 1 year Certificate Course in EARLY CHILDHOOD CARE AND EDUCATION** **36**

# SEMESTER-WISE STUDY PROGRAMME FOR 1 YEAR CERTIFICATE COURSE IN EARLY CHILDHOOD CARE AND EDUCATION

**FIRST YEAR**

**SEM I**

| | | |
|---|---|---|
| 1. | HDFS 51 | 1+2 |
| 2. | HDFS 52 | 3+1 |
| 3. | HDFS 53 | 2+2 |
| 4. | HDFS 54 | 1+3 |
| 5. | EECM 54 | 1+2 |
| | | 8+10=18 |

**SEM II**

| | | |
|---|---|---|
| 1. | HDFS 55 | 2+2 |
| 2. | HDFS 56 | 2+2 |
| 3. | HDFS 57 | 2+2 |
| 4. | RMCS 58 | 2+1 |
| 5. | EECM 52 | 1+2 |
| | | 9+9=18 |

## Course curriculum for Certificate Course in Interior design and decoration- I year programme

**CORE COURSES**

**COLLEGE OF COMMUNITY SCIENCE**

| | | | | |
|---|---|---|---|---|
| 1 | RMCS | 51 | Fundamentals of Art and Interior Enrichment | 2+1 |
| 2 | RMCS | 52 | Housing and Space Management | 2+1 |
| 3 | RMCS | 53 | Walls and Ceilings : Styles & Finishes | 2+1 |
| 4 | RMCS | 54 | Furniture Design and Arrangement | 2+1 |
| 5 | RMCS | 55 | Windows and Window Treatments | 2+1 |
| 6 | RMCS | 56 | Computer Applications in Interior Designing | 0+2 |
| 7 | RMCS | 57 | Residential and Commercial Space Designing (In collaboration with Department of Civil Engineering, PAU, Ludhiana) | 2+1 |
| 8 | RMCS | 58 | Floor and Floor Coverings | 2+1 |
| 9 | RMCS | 59 | Colour and Lighting in Interiors | 2+1 |
| 10 | RMCS | 60 | Special Project | 0+4 |
| 11 | EECM | 51 | Fundamentals of Communication | 2+1 |
| 12 | HDFS | 51 | Personality and Value Education | 1+2 |
| | | | | 19+17 |

Total Credit hour requirement for 1 year Certificate Course in Interior Design and Decoration. 36

## SEMESTER-WISE STUDY PROGRAMME FOR 1 YEAR CERTIFICATE COURSE IN INTERIOR DESIGN AND DECORATION

**ONE YEAR**

| **Semester I** | | | **Semester II** | | |
|---|---|---|---|---|---|
| Course No. | Course Title | Cr.Hrs | Course No. | Course Title | Cr.Hrs |
| RMCS 51 | Fundamentals of Art and Interior Enrichment | 3(2+1) | RMCS 55 | Windows and Window Treatments | 3(2+1) |
| RMCS 52 | Housing and Space Management | 3(2+1) | RMCS 56 | Computer Applications in Interior Designing | 2(0+2) |
| RMCS 53 | Walls and Ceilings : Styles & Finishes | 3(2+1) | RMCS 57 | Residential and Commercial Space Designing (In collaboration with Department of Civil Engineering, PAU, Ludhiana) | 3( 2+1) |
| RMCS 54 | Furniture Design and Arrangement | 3( 2+1) | RMCS 58 | Floor and Floor Coverings | 3( 2+1) |
| EECM 51 | Fundamentals of Communication | 3(2+1) | RMCS 59 | Colour and Lighting in Interiors | 3 (2+1) |
| HDFS 51 | Personality and Value Education | 3 (1+2) | RMCS 60 | Special Project | 4(0+4) |
| | Total | 18(11+7) | | Total | 18 (8+10) |

SECTION XI

# FACULTY OF BASIC SCIENCES AND HUMANITIES

## General Information

### Disciplines

- Biochemistry
- Botany
- Business Studies
- Chemistry
- Economics and Sociology
- Journalism, Languagues and Culture
- Mathematics, Statistics and Physics
- Microbiology
- Zoology
- Course curriculum for Award of 3-year B.Sc. Degree on opting out of 5-year integrated M.Sc. (Hons) Programme in Biochemistry
- Semester-wise Programme for 5-year Integrated M.Sc. (Hons) in Biochemistry
- Course curriculum for Award of 3-year B.Sc. Degree on opting out of 5-year integrated M.Sc. (Hons) Programme in Botany
- Semester-wise Programme for 5-year Integrated M.Sc. (Hons) in Botany
- Course curriculum for Award of 3-year B.Sc. Degree on opting out of 5-year integrated M.Sc. (Hons) Programme in Chemistry
- Semester-wise Programme for 5-year Integrated M.Sc. (Hons) in Chemistry
- Course curriculum for Award of 3-year B.Sc. Degree on opting out of 5-year integrated M.Sc. (Hons) Programme in Microbiology
- Semester-wise Programme for 5-year Integrated M.Sc. (Hons) in Microbiology
- Course curriculum for Award of 3-year B.Sc. Degree on opting out of 5-year integrated M.Sc. (Hons) Programme in Physics
- Semester-wise Programme for 5-year Integrated M.Sc. (Hons) in Physics
- Course curriculum for Award of 3-year B.Sc. Degree on opting out of 5-year integrated M.Sc. (Hons) Programme in Zoology
- Semester-wise Programme for 5-year Integrated M.Sc. (Hons) in Zoology
- Course curriculum for B.Sc. (Hons) Agribusiness Management Programme
- Semester-wise Programme for B.Sc. (Hons) Agribusiness Management Programme

# COLLEGE OF BASIC SCIENCES AND HUMANITIES

Basic Sciences provide scientific capital from which practical application of knowledge is drawn. Keeping in view the significance of basic sciences and humanities for proper understanding and development of different areas of agriculture and allied fields, the College of Basic Sciences and Humanities was established in October, 1965. Dr A S Kahlon was the founder Dean of the College and he continued in this position up to October, 1978. Subsequently, Dr Kulbir Singh Gill (December, 1978 to February, 1982; August, 1983 to January, 1986), Dr I S Bhatia (February, 1982 to July, 1983), Dr S S Guraya (January, 1986 to May, 1990), Dr C P Malik (June, 1990 to June, 1994), Dr D R Singh (June, 1994 to July, 1996), Dr H S Garcha (April, 1998 to March, 2000), Dr M.A. Zahir (April, 2000 to December, 2002), Dr A P S Mann (January, 2003 to September, 2005) and Dr Tejwant Singh (October, 2005 to July, 2009), Dr R S Sidhu (December, 2009 to January, 2015), Dr (Mrs) G K Sangha (March, 2015 to January, 2019) served as Deans of the College. Presently, Dr Shammi Kapoor is working as the Dean of the College since August, 2019. As a constituent college of the University, the College of Basic Sciences and Humanities strives to be a centre of excellence for advanced studies in the various fields within its jurisdiction.

Its teaching and research objectives are:

i) To impart training and to equip students in basic sciences and humanities (both at UG and PG levels) to provide a scientific base for proper understanding and appreciation of the applied subjects of agriculture, home science and agricultural engineering and technology as well.

ii) To perform integrated functions of resident instruction, research and extension in all the disciplines of basic sciences and humanities.

iii) To promote inter-disciplinary resident instruction, research and extension education programmes at the Punjab Agricultural University.

Before the establishment of PAU, the subjects in basic sciences were taught to B.Sc. (Agri) students by different sections of Govt. Agricultural College, Ludhiana. After the establishment of PAU in 1962, five independent departments (viz., Department of Agricultural Journalism, Languages and Culture; Department of Chemistry and Biochemistry; Department of Economics and Sociology; Department of Genetics and Department of Physics, Mathematics and Statistics) were created in 1963 to teach the subjects of basic sciences and humanities.

The Department of Microbiology was established in the College in 1969. The Department of Business Management was established in 1971 to train students in entrepreneurship and management disciplines. Two more independent departments were established in 1972, viz., Department of Botany by splitting the Department of Botany and Plant Pathology (COA) and Zoology by splitting the Department of Zoology and Entomology (COA). In the same year, an independent Department of Physics was also carved out of combined Department of Physics, Mathematics and Statistics. In 1976, the Department of Chemistry was established by bifurcating the Department of Chemistry and Biochemistry. Keeping in view the role of biotechnology in augmenting agricultural production, an independent Biotechnology Centre was established in 1992 which was merged with Department of Genetics in the year 2000, which has now been shifted to the College of Agriculture. An independent Department of Fisheries was carved out from the Department of Zoology in 1994, which was later shifted to Guru Angad Dev Veterinary and Animal Sciences University in the year 2006. The upgradation of the Department of Business Management to School of Business Studies was done in the year 2012.

At present, the College has eight departments namely, Agricultural Journalism Languages and Culture; Biochemistry; Botany; Chemistry; Economics and Sociology; Mathematics, Statistics and Physics; Microbiology; Zoology and one School i.e. the School of Business Studies. The College is running 28 teaching programmes, which comprise 8 Ph.D., 13 M.Sc., 6 M.Sc.(Hons) Integrated, 1 B.Sc. (Hons) Agribusiness Management. In addition to this 1 Diploma in French and two Certificate Courses, one in French, and the second in Interactive Skills and Personality Enhancement are also offered.

The details of various degree courses are given below. The year of start of these programmes is shown in parentheses.

| | |
|---|---|
| Agricultural Economics | M.Sc. (1963), Ph.D. (1965) |
| Biochemistry | M.Sc. (1963), Ph.D. (1963), 5-year Integrated M.Sc. (Hons) (2008) |
| Botany | M.Sc. (1963), Ph.D. (1968), 5-year Integrated M.Sc. (Hons) (2008) |
| Agribusiness Management | B.Sc. (Hons) Agribusiness Management (2021) |
| Business Administration | MBA (1971), Ph.D. (1971) |
| Business Administration (Agribusiness) | MBA (Agribusiness) (2004) |
| Chemistry | M.Sc. (1968), Ph.D. (1972), 5-year Integrated M.Sc. Hons (2011) |
| Journalisim and Mass Communication | MJMC (2008) |
| Microbiology | M.Sc. (1969), Ph.D. (1972), 5-year Integrated M.Sc. Hons (2008) |
| Mathematics | M.Sc. (2021) |
| Physics | M.Sc. (2011), 5-year Integrated M.Sc. (Hons) (2021) |
| Statistics | M.Sc. (2016) |
| Sociology | M.Sc. (1967), Ph.D. (1969) |
| Zoology | M.Sc. (1972), Ph.D. (1972), 5-year Integrated M.Sc. (Hons) (2008) |

M.Sc. and Ph.D. programmes in Statistics were started in 1966 and 1968 but discontinued from academic year 1999-2000 and 1998-99, respectively. M.Sc. in Statistics has been revived w.e.f. academic year 2016-17. Ph.D. programme in Physics was started in 1992 but discontinued from the academic session 1998-99. B.Sc. (Hons) programmes in Biochemistry, Botany, Chemistry, Statistics and Zoology were initiated from academic session 1970-71. The programme in Statistics was discontinued from the academic session 1975-76 while the remaining 4 programmes were discontinued from the academic session 1985-86. B.Sc. (Hons) Agribusiness Management, M.Sc. Mathematics and 5-Year Integrated M.Sc. (Hons) in Physics were started from the academic session 2021-22. Total number of students who received B.Sc.(Hons) degree were 366 (Biochemistry-106, Botany-70, Chemistry- 96, Statistics-10 and Zoology-84).

The College of Basic Sciences and Humanities has a special role to play in the University because it gives support to all the other Colleges. The College, through its own Board of Studies, approves courses in basic sciences and humanities for all the constituent colleges of the University, as per their needs and requirements. Since students in the College of Agriculture, College of Home Science and College of Agricultural Engineering and Technology are admitted after 10$^{th}$ and 10+2, they are deficient in knowledge in some of the basic sciences and the languages. For the students admitted after 10$^{th}$ at IOA, Gurdaspur and IOA, Bathinda, the new courses were framed to make them equivalent with PSEB curriculum of 10+1 and 10+2. The courses offered by the College, thus, form the scientific base for studying applied courses for the students of these colleges. Many of the courses offered by the various departments of the College are taken by the postgraduate students of different disciplines of the other colleges as minor or supporting courses.

The undergraduate and postgraduate courses offered by the College were revised and updated in the academic year 1982-83. Later on, when the University switched over to semester system in 1988-89, all the courses were again revised/rescheduled and new courses were designed to impart knowledge in Molecular Biology, Genetic Engineering and Biotechnology, Physiology of Plants and Animal and specialized areas in Microbiology including mushroom cultivation. Based on recent advances and changing scenario in sciences, again many of the courses have been revised/modified and new courses added in the academic year 1998-99. New curricula was designed for 5-Year Integrated M.Sc. (Hons) programmes in 2008. The entire curriculum for PG courses was restructured again in the year 2010-11 in accordance with the ICAR guidelines. The undergraduate courses offered by the College has been revised as per Fifth Deans' Committee recommendations. The course

curriculum of 5-Year Integrated M.Sc. (Hons) programmes was revised in 2017. Presently, the entire curriculum for PG courses is restructed as per the recommendation of BSMA w.e.f academic session 2022-23.

The College has well equipped centralized facilities such as PG Research Laboratory, Molecular Biology Laboratory, Computer Laboratory, Smart Class Rooms, Central Instrument Laboratory, Media Lab, Language Lab, Statistical Lab, Zoological Museum, Botanical Garden, Experiential Learning Programme (Mushroom), Biofertilizers Unit, Fermentation Lab and Water Testing Lab to cater to the needs of faculty and research scholars. The College has been recognized for its role through various awards and honours received by the faculty and students over the years. The distinguished awards include Shanti Swaroop Bhatnagar Award, Rafi Ahmed Kidwai Award, Hari Om Trust Ashram Award, Hira Lal Chakraborty Award, Basanti Devi and Amar Chand Award and the RT Doshi Foundation Award. The faculty/students have been nominated/elected fellows of NAAS, FNA, German Academic Exchange (DAAD) Fellowship, Fulbright Nehru Fellowship, Cambridge Nehru Scholarship, Commonwealth Academic Staff Scholarships and others.

# BIOCHEMISTRY

## PROGRAMMES

**M. Sc.**
**Ph. D.**
**Five Year Integrated M.Sc. (Hons)**

## COURSE REQUIREMENTS:

### M.Sc.

| | |
|---|---|
| Fields of specialization | Plant Biochemistry, Molecular Biology, Enzymology, Abiotic and Biotic Stress Biochemistry |
| Required courses | Biochem.-501, Biochem.-502, Biochem.-503, Biochem.-504, Biochem.-505, Biochem.-507 |
| Supporting courses | Stat.-502 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Botany, Microbiology, Food Science and Technology, Plant Breeding and Genetics, Biotechnology or any other as approved by the Dean Post Graduate Studies. |
| Deficiency courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D.

| | |
|---|---|
| Fields of specialization | Plant Biochemistry, Molecular Biology, Enzymology, Abiotic and Biotic Stress Biochemistry |
| Required courses | Biochem.-601, Biochem.-602, Biochem.-603, Biochem.-607 |
| Supporting courses | Courses from subject matter fields (other than minor) relating to area of special interest and research problem |
| Minor fields | Botany, Microbiology, Food Science and Technology, Plant Breeding and Genetics, Biotechnology or any other as approved by the Dean Post Graduate Studies. |
| Deficiency courses | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Five Year Integrated M.Sc. (Hons)

| | |
|---|---|
| Fields of specialization | Plant Biochemistry, Molecular Biology, Enzymology, Abiotic and Biotic Stress Biochemistry |
| Required courses | All courses listed for semesters I to VI and Biochem. 501, Biochem.-502, Biochem.-503, Biochem.-504, Biochem.-505, Biochem.-507 |
| Supporting courses | Stat.-502 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Botany, Microbiology, Food Science and Technology, Plant Breeding and Genetics, Biotechnology or any other as approved by the Dean Post Graduate Studies. |
| Deficiency courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate courses/Integrated M.Sc. (Hons)

**Biochem. 101 Introduction to Biochemistry** **2+1** **Sem. I**

Importance of Biochemistry. Properties of Water, pH and Buffer. Carbohydrate: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Polysaccharides. Lipid: Importance and classification; Structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: Importance of proteins and classification; Structures, titration and zwitterions nature of amino acids; Structural organization of proteins. Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes. Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

**Practical :** Preparation of solution, pH & buffers, Qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids/ Free fatty acids, Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides.

**Biochem. 102 Nutritional Biochemistry-I** **2+1** **Sem. I**

Introduction to biochemistry - Definition, objectives, scope and inter relationship between biochemistry and other biological sciences. Enzymes - Definition, types and classification of enzymes, definition and types of coenzymes, specificity of enzymes, isozymes, enzyme kinetics including factors affecting enzyme action, velocity of enzyme catalyzed reactions, enzyme inhibition. Intermediary metabolism. Carbohydrate metabolism- glycolysis, TCA cycle and energy generation, gluconeogenesis, glycogenesis, glycogenolysis, blood sugar regulation. Lipid metabolism - oxidation and biosynthesis of fatty acids (saturated and mono-unsaturated), synthesis and utilization of ketone bodies, ketosis, fatty liver. Protein metabolism - general reactions of amino acid metabolism, urea cycle, lipoproteins - types, composition, role and significance in disease.

**Practical :** Handling of equipment and instruments, preparation of samples, solutions and buffers, blood constituents: Estimation of serum protein (Biuret method and Lowry method), blood glucose (Folin Wu method), serum inorganic phosphorus (Fiske and SubbaRow method), creatinine, Urine constituents: Estimation of protein levels, glucose levels in urine, ketone bodies in urine, urine constituents- Repeat.

**Biochem. 103 Nutritional Biochemistry-II** **3+0** **Sem. II**

Role of major biomolecules in nutrition. Introduction to nucleic acids-DNA, RNA and their structure, replication, transcription, genetic code and biosynthesis of proteins. Vitamins -chemistry and biochemical role of fat-soluble vitamins - A, D, E and K, water soluble vitamins - B1, B2, B6, niacin and vitamin C. Biochemical role of minerals in nutrition- macrominerals- calcium, iron, magnesium, sodium, potassium, chloride, phosphorus and sulphur, microminerals – iodine, zinc, copper, chromium, selenium, cobalt, fluoride and manganese. Anti-nutrients and antioxidants in human health. Digestion and absorption of carbohydrates, lipids, proteins, vitamins and iron. Bile acid metabolism. Molecular aspects of transport, passive diffusion, facilitated diffusion, active transport of sugars and amino acids. Basal metabolism and caloric requirements. Balanced diet. Metabolic disorders of macromolecules- glycogen storage diseases, lipidosis, dyslipidemias and atherosclerosis. Evaluation of protein quality by chemical and biological methods. Protein energy malnutrition- marasmus and kwashiorkor and their management.

**Biochem. 104 Principles of Biochemistry** **2+1** **Sem. II**

Recapitulation of basic chemistry and biology. Water. pH and buffers. Acid-base balance. Cellular constituents and their structure and function- amino acid and proteins, carbohydrates, lipids and bio-membranes, nucleic acids. Dissolved molecules– vitamins and minerals. Enzymes-function, properties

and mechanism. Metabolism of cellular constituents- basic concepts of bioenergetics. Carbohydrate metabolism-glycolysis and glycogenolysis, HMP pathway, TCA cycle and gluconeogenesis. Electron transport chain. Photosynthesis. Lipid metabolism-β-oxidation, ketone bodies, fatty acid synthesis. Amino acid metabolism - general reactions of nitrogen assimilation and excretion. Biosynthesis of DNA, RNA and protein- replication, transcription, translation and genetic code. Regulation of gene expression.

**Practical :** Preparation of buffers and pH determination. Preparation of colloids. Qualitative and quantitative tests of carbohydrates, lipids and proteins. Tests of enzyme action- potato oxidase, urease, salivary amylase. Paper chromatography of amino acids or carbohydrates ascending and descending. Determination of starch and sugar. Analysis of proximate constituents in food.

**Biochem. 203 Structure and Function of Biomolecules 3+0 Sem. II**

Development and scope of Biochemistry. Biochemical composition of living organisms. Water as a solvent of life. Buffers and Henderson-Hasselbalch equation. Structure and functions of simple and complex carbohydrates. Lipids: classification, structure and functions; Proteins: structures of amino acids, concept of peptide bond, levels of protein structure and protein functions. Nucleic acid: nucleoside, nucleotides, structure of DNA and RNA and their functions. Vitamins and coenzymes.

**Biochem. 206 General Enzymology 2+0 Sem. II**

Classification and nomenclature of enzymes. General characteristics of enzymes. Active site, cofactors, prosthetic groups; metallo-enzymes. Enzyme assays and international units. Enzyme kinetics: significance of Km and Vmax and their determination using Lineweaver-Burk plots. Enzyme inhibition: Reversible and irreversible, competitive, non-competitive and uncompetitive with graphical representations. Brief mention of allosteric enzymes and isoenzymes. Biotechnological and clinical applications of enzymes.

**Biochem. 207 Basic Biochemistry 3+1 Sem. II**

Introduction and importance. Cell structure. Bio molecules - structure, functions and properties of carbohydrates, lipids, proteins and nucleic acids. Enzymes – classification and factors affecting activity. Structure and role of water in biological system. Acids, bases and buffers of living systems. The pK of biomolecules. Vitamins- chemistry, classification, biochemical role and deficiency diseases. Hormones - classification, general mode of action and role in metabolism. Bioenergetics. Metabolism - basic concept, Glycolysis, Citric acid cycle, Pentose phosphate pathway, Oxidative phosphorylation, Fatty acid oxidation. General reactions of amino acid degradation-transamination, deamination, decarboxylation and urea cycle. Biosynthesis - carbohydrates, lipids, proteins and nucleic acids. Secondary metabolites - terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.

**Practical :** Qualitative tests for carbohydrates, amino acids, proteins and lipids. Extraction and characterization of lipids by thin layer chromatography. Determination of acid, iodine and saponification values of oil. Extraction, quantitative estimation and separation of sugars by paper chromatography. Determination of phenols. Determination of free amino acids and proteins.

**Biochem. 208 Food Biochemistry and Nutrition 2+1 Sem. II**

Biochemistry and its scope. Occurrence, classification, structures, physicochemical and metabolic functions of carbohydrates, proteins and lipids. Nucleic acids - properties, structure and metabolism. Enzymes - chemical nature, nomenclature, classification, sources and properties, mechanism of action, coenzyme and prosthetic groups, regulation of enzymatic activity, enzyme kinetics, inhibition, effects of pH, allosteric enzymes, derivation of Michaelis Menten equation. Concepts and content of nutrition - water and energy balance, water intake and losses, basal metabolism. Formulation of diets - classification and preparation of balanced diet, recommended dietary allowances for various age groups. Malnutrition - assessment of nutritional status, food fad and faddism. Potentially toxic substance in human food. Basic food groups and nutrients supplied by food. Digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings. Metabolism of carbohydrates - glycolysis and respiration, production of ATP, brief description of electron transport chain, oxidative and substrate phosphorylation. Metabolism of Lipids- β oxidation of fatty acids, ketosis, fatty acid synthesis. Metabolism of proteins- breakdown of proteins, transamination, deamination, decarboxylation and urea cycle. Minerals - functions, sources and effects of deficiency. Factors affecting absorption of minerals,

promoters and inhibitors. Vitamins and hormones - classification, functions, sources and effects of deficiency. Fat soluble and water-soluble vitamins. Physico-chemical and nutritional changes during food processing - drying and dehydration, irradiation, freezing, fermentation, canning, restoration, enrichment, fortification and supplementation of foods.

**Practical :** Preparation of various solutions and buffers. Qualitative and quantitative determination of carbohydrates, amino acids, proteins and lipids. Isolation of enzymes from various sources. Determination of pKa of acid and pI for casein. Separation of amino acids using paper chromatography, thin layer chromatography and electrophoresis. Estimation of phosphorus, calcium and iron in food samples. Estimation of β-carotene using column chromatography. Vitamins -Estimation of ascorbic acid using dye method. Effects of acids and alkali on pigments.

**Biochem. 209 Introduction to Intermediary Metabolism** **3+0** **Sem. I**

Bioenergetics: High energy compounds, chemical potential, electrochemical potential, electron transport chain and oxidative phosphorylation. Metabolism of carbohydrates: glycolysis, gluconeogenesis, tricarboxylic acid cycle, pentose phosphate pathway. Glycogen metabolism. Glyoxylate pathway. Oxidation of fatty acids. Biosynthesis of fatty acids. Cholesterol, phospholipid, and triglyceride metabolism. General reactions of amino acids – transamination, deamination and decarboxylation and urea cycle. Biosynthesis and degradation of purine and pyrimidine nucleotides. Biosynthesis of deoxyribonucleotides. Common diseases of metabolism.

**Biochem. 301 Introduction to Molecular Biochemistry** **3+0** **Sem. I**

Introduction; Structure of DNA (A, B and Z) and RNA, DNA replication: semi-conservative mode of replication and its experimental verification. Enzymes involved in DNA replication. Differences between prokaryotic and eukaryotic replication. RNA biosynthesis: Initiation, elongation and termination, reverse transcriptase. Genetic code: Elucidation and general features. Protein synthesis, enzymes involved in translation. Post-transcriptional processes. Introduction to operon concept (lac-operon) and regulation of gene expression.

**Biochem. 302 Basic Experiments in Biochemistry** **0+3** **Sem. II**

**Practical :** Qualitative tests for carbohydrates, lipids, proteins and amino acids. Determination of acid, iodine and saponification values of fats and oils. Extraction of total lipids and total sugars. Estimation of total sugars, reducing sugars and starch. Starch hydrolysis by amylase. Preparation of buffers. Determination of acid phosphatase from mungbean. Separation of sugars by paper chromatography and lipids by thin layer chromatography.

**Biochem. 303 Introduction to Membrane Biochemistry** **3+0** **Sem. I**

Chemical composition of biomembranes. Role of phospholipids and proteins, models of cell membranes. Functions of membranes: energy transduction, signal recognition and transduction. Nutrient transport across membranes. Active and passive transport. Pumps: examples and metabolic significance. Bacteriorhodopsin. Membrane fluidity and receptor functions.

**Biochem. 304 Enzymology and Enzyme Technologies** **2+1** **Sem. I**

Classification and nomenclature of enzymes. General characteristics of enzymes. Active site. Cofactors and prosthetic groups. Metalloenzymes. Isolation, purification, characterization and assays of enzyme and international units. Criteria for purity. Enzyme kinetics- effect of pH, temperature, enzyme and substrate concentration. Determination of Km and Vmax. Regulation of enzyme activity. Enzyme inhibition- competitive, non-competitive and uncompetitive. Isoenzymes, schizomers and isoschizomers. Ribozymes, Immobilization of enzymes. Applications of enzymes in biotechnology, industry, environment, agriculture, food and medicine.

**Practical :** Isolation, purification and assay of enzymes. Determination of optimum pH and optimum temperature of enzymes. Thermostability of enzymes. Activators and inhibitors of enzyme catalysis. Determination of kinetic parameters of enzymes. Immobilization of enzymes. Isoenzymes analysis.

**Biochem. 421 Fundamentals of Biochemistry** **3+0** **Sem. I**

Cell structure and function. Structure and role of water in biological system. Acids, bases and buffers of living systems. The pK of biomolecules. Classification of enzymes. Effect of substrate, temperature, pH, activators and inhibitors on enzyme catalysis. Vitamins and hormones. Bio- membranes structure and function. Bioenergetics and oxidative phosphorylation. Metabolism of carbohydrates, lipids, proteins, nucleic acids. Photosynthesis and respiration. DNA replication, transcription and translation. Regulation of transcription. Recombinant DNA technology. Secondary plant products.

**Biochem. 423 Fundamentals of Molecular Biochemistry** **2+0** **Sem. I**

Introduction Structure and functions of nucleic acids. Nucleic acids as genetic material. DNA sequencing. DNA replication, mutations and repair mechanism. Transcription and post transcriptional modifications. Genetics code. Protein biosynthesis. Protein targeting. Regulation of gene expression at the level of transcription. Recombinant DNA and concepts of biotechnology.

**Biochem. 424 Experiments in Biochemistry** **0+3** **Sem. II**

**Practical:** Concepts of pH and buffers. Determination of total sugars, reducing and non-reducing sugars, starch, free fatty acids, cholesterol and phospholipids. Determination of free amino acids and proteins. Separation of sugars by paper chromatography. Extraction of lipids, separation of polar and non-polar lipids by TLC. Fatty acid composition by GLC. Estimation of Vitamin C and tocopherols. Isolation and purification of acid phosphatase. Estimation of chlorophyll, carotenoids and phytic acid. Extraction and estimation of nucleic acids.

**Biochem. 425 Fundamentals of Plant Biochemistry** **2+0** **Sem. I**

Structure and function of cell wall and cell organelles. Photosynthesis and photorespiration. Sucrose transport. Biosynthesis of structural and storage carbohydrates, proteins and lipids. Biochemistry of seed development. Biological nitrogen fixation. Nitrogen and sulfur metabolism. Secondary plant products and their role. Growth regulators. Biochemistry of biotic and abiotic stresses. Carbohydrate and lipid metabolism during germination.

**Biochem. 426 Fundamentals of Animal Biochemistry** **3+0** **Sem. II**

Composition and secretion of digestive juices. Digestion and absorption of lipids, proteins, carbohydrates and nucleic acids. Role of lipoproteins in transport of lipids. Acid base balance in kidney and lung functions. Composition of blood and blood clotting. Metabolism and functions of hemoglobin. Biochemistry of specialized tissues like muscles, eyes, nerves and connective tissues. Hormones and their mechanism of action. Role of thyroid, pituitary and calcium metabolizing hormones. Detoxification of xenobiotics. Introduction to immune system and immune cells. Antibodies: classes and functions. Antigen-antibody interactions. Production of monoclonal and polyclonal antibodies.

**Biochem. 429 Biochemical and Biophysical Techniques** **3+0** **Sem. II**

Separation techniques like salt and organic solvent fractionation; dialysis, osmosis and ultra-filtration. Chromatographic techniques- partition, adsorption, ion exchange, thin layer, molecular sieve, affinity, high pressure liquid chromatography and GLC. Electrophoresis and isoelectric focusing. X-ray diffraction, ORD and circular dichroism and their application. Lyophilization. Centrifugation techniques: basic principles of sedimentation; centrifuges of various types; Rotors: differential centrifugation, density gradient centrifugation, applications of the analytical ultracentrifuge. Instrumentation methods-IR, UV and visible spectrophotometry, spectrofluorimetry, ESR, NMR spectroscopy. Atomic spectroscopy, Radioactive counters. Radioisotopes in biology: Applications and precautions.

**Fundamentals of Enzymology** **3+0** **Sem. II**

Introduction to enzymes. Naming and classification of enzymes. Enzymes specificity, cofactors, coenzymes and prosthetic groups. Isozymes, nature of active site, concept of pKa of amino acids. Identification of functional groups of active site. Factors responsible for catalytic efficiency of enzymes. Concept of initial velocity, enzyme units, specific activity, Michaelis-Menten equation, concept of Km and Vmax. Enzyme inhibition and activation, bi-substrate reactions, regulation of enzyme activity. Allosteric

enzymes. Enzyme isolation and purification. Enzyme immobilization. Biotechnological applications of enzymes.

**Biochem. 431 Fundamentals of Membrane Biochemistry** **2+0 Sem. II**

Membrane composition and functions. Various models of unit membrane structure. Comparison of membranes of cells and organelles. Distribution of membrane compounds and their role in organization of membrane and cellular recognition. Membrane transport mechanisms. Membrane channels and pumps. Gap junctions and tight junctions. Transport of different nutrients. Membrane mediated processes and membrane receptors. Signal recognition and transduction.

**Biochem. 432 Clinical Biochemistry** **2+1 Sem. II**

Role of Biochemistry in diagnosis of diseases. Composition of blood: serum, plasma proteins, RBC, WBC, and platelets. Disorders of carbohydrate metabolism; glucose level in normal blood, renal threshold, hyper and hypoglycemia, qualitative tests for sugars in diagnosis of diabetes mellitus. Glycogen storage diseases. Disorders of amino acid metabolism: phenyl alanemia, homocystinuria, tyrosinemia, maple syrup urine disease, alkaptonuria and aminoacidurias. Disorders of lipid metabolism: Plasma lipoproteins, cholesterol, phospholipid and triglyceride in health and diseases, ketosis, fatty lever, lipidosis. Disorders of nucleic acid metabolism. Diagnostic enzymes related to GIT, liver and kidney function tests. Hemoglobin metabolism, hemoglobinopathies, thalessmia, anemias and porphyrias. Disorders of mineral metabolism. Hormonal disturbances: steroid and protein hormone, thyroid function.

**Practical :** Separation of serum and plasma from blood, Estimation of hemoglobin blood sugar, cholesterol, phospholipids and triglycerides, Estimation of calcium, phosphorus, sodium, potassium, urea, uric acid, and creatinine in serum. Assay of aminotransferases (SGOT and SGPT), amylase, phosphatases, and lipase in serum. Albumin/globulin ratio. Separation of plasma proteins by electrophoresis. ELISA. Thyroid function test: T3 and T4 assay.

## Postgraduate courses

**Biochem.-501 Basic Biochemistry** **3+1 Sem I**

**Unit I** Biochemistry as modern science and its various divisions, Scope, and importance of Biochemistry in agriculture and allied sciences.

**Unit II** Fundamental principles governing life, supramolecular structures, significance of weak non-covalent interactions in biology.

**Unit III** Structure of water, ionization of water, acid base concept, pH and buffers, significance of structure-function relationship.

**Unit IV** General introduction to physical techniques for determination of structure of biopolymers.

**Unit V** Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids.

**Unit VI** Structure, formation and different forms of immunoglobulins, PR proteins and their classification.

**Unit VII** Structure, classification, and function of plant secondary metabolites.

**Unit VIII** Structure and biological functions of vitamins and coenzymes, enzymes: classification and mechanism of action; regulation, factors affecting enzyme action. Hormones: animal and plants.

**Unit IX** Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

**Unit X** Important and basic degradative metabolic pathways of carbohydrates, lipids and proteins and their regulation.

**Unit XI** Formation of ATP, substrate level phosphorylation, electron transport chain and oxidative phosphorylation, chemiosmotic theory and proton motive force.

**Unit XII** Overview of replication, transcription, and translation.

**Unit XIII** Restriction enzymes, DNA cloning, applications of cloning, transgenics.

**Practical :** Preparation of standard and buffer solutions. Detection of carbohydrates, amino acids and proteins. Extraction and estimation of sugars. Extraction and estimation of amino acids. Extraction and estimation of proteins. Estimation of acid value of fat/oil. Estimation of peroxide value of fat/oil. Estimation of saponification value in fats and oils. Fatty acid composition in fat/oil by GC. Estimation of DNA and RNA by spectroscopic methods. Estimation of Ascorbic acid. Separation of biomolecules by TLC and Paper chromatography. Estimation of alpha amylase activity. Qualitative tests for secondary plant metabolites.

**Biochem.-502 Intermediary Metabolism** **3+0** **Sem II**

**Unit I** The living cell - a unique chemical system, biochemical reaction types, bioenergetics, bioavailability of nutrients, transport mechanism, signal transduction.

**Unit II** Catabolism and anabolism, compartments of metabolic pathways, experimental approaches to study metabolism, metabolic profiles of major organs.

**Unit III** Major catabolic and anabolic pathways of carbohydrate metabolism, the glyoxylate pathway.

**Unit IV** Fatty acid oxidation, ketone bodies, fatty acid biosynthesis, synthesis of triacylglycerols, cholesterol, eicosanoids.

**Unit V** General reactions of amino acid metabolism, degradative and biosynthetic pathways of amino acids, urea cycle, amino acids as metabolic precursors.

**Unit VI** Mechanisms of energy transduction, electron transport system, oxidative phosphorylation, control of ATP production.

**Unit VII** Sulphate reduction and incorporation of sulphur into amino acids.

**Unit VIII** Synthesis and degradation of purine and pyrimidine nucleotides.

**Unit IX** Regulation of carbohydrate, lipid, protein, nucleotide metabolism and oxidative phosphorylation

**Unit X** Disorders of carbohydrates, lipids, amino acids, and nucleic acid metabolism, and inborn errors of metabolism. Metabolic pathway engineering.

**Biochem.-503 Enzymology** **2+1** **Sem I**

**Unit I** Historic perspective, general properties of enzymes, enzyme compartmentalization in cell organelles, nomenclature and classification of enzymes, ribozymes, isozymes, abzymes.

**Unit II** Extraction of soluble and membrane-bound enzymes, purification of enzymes, measurement of enzyme activity.

**Unit III** Enzyme specificity, monomeric and oligomeric enzymes, catalytic mechanism, mechanism of enzyme action, pseudoenzymes, enzyme promiscuity.

**Unit IV** Chemical nature and involvement of cofactors and coenzymes in enzyme catalyzed reactions, metal activated enzymes and metalloenzymes, mechanism of enzyme catalyzed reactions without cofactors.

**Unit V** Active site, identification of binding sites and catalytic sites.

**Unit VI** Relationship between initial velocity and substrate concentration, Michaelis-Menten equation, Lineweaver-Burk and Eadie-Hofstee plots, analysis of kinetic data, numerical exercises.

**Unit VII** Reversible and irreversible enzyme inhibition, uses of enzyme inhibition.

**Unit VIII** Nature of allosteric enzymes, sigmoidal kinetics, MWC model and allosteric regulation, KNF model and allosteric regulation.

**Unit IX** Feedback regulation, regulatory enzymes, control of enzymatic activity, symmetry and sequential model, reversible covalent modification of enzymes.

**Unit X** Industrial application of enzyme catalysis in sectors like food processing, detergents, biofuels, paper and pulp, biosensors, and clinical applications of enzymes.

**Unit XI** Large scale production and purification of enzymes, immobilization of enzyme.

**Practical :** Soluble protein estimation. Enzyme assay by taking any model enzyme. Isolation and purification of any model enzyme. Study of the effect of enzyme and substrate concentrations on enzyme activity. Determination of Km and Vmax. Determination of pH and temperature optima. Effect of inhibitors on enzyme activity. Determination of pH and temperature stability of enzyme. Electrophoretic analysis of isozymes.

**Biochem.-504 Molecular Biology 2+1 Sem II**

**Unit I** Historical development of molecular biology, nucleic acids as genetic material.

**Unit II** Nucleic acid structure, chemical and physical properties of nucleic acids, spectroscopic and thermal properties of nucleic acids, DNA supercoiling.

**Unit III** Concept of genes and genome, genome complexity, genome organization in prokaryotes and eukaryotes, chromatin structure and function, repetitive and non-repetitive DNA, satellite, DNA central dogma, genome editing.

**Unit IV** Modes of replication, DNA polymerases, topoisomerases, DNA ligase, model of replisome, semi conservative replication in prokaryotes and eukaryotes, inhibitors of replication, DNA damage and repair.

**Unit V** Basic principles of transcription, transcription initiation, elongation and termination, RNA processing, RNA interference, siRNAs, miRNAs and other ncRNAs, DNA/RNA editing, regulation of transcription, reverse transcription.

**Unit VI** Ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl tRNA synthases.

**Unit VII** Initiation, chain elongation and termination of translation, energetics, inhibitors of translation.

**Unit VIII** Post translational modifications of nascent polypeptide, protein targeting and turnover, regulation of gene expression in prokaryotes and eukaryotes, nucleases, and restriction enzymes.

**Unit IX** Importance, Sanger method, High-Throughput Sequencing (HTS) techniques, applications of DNA sequencing.

**Unit X** Vectors, isolation of genes, recombinants vector, selection of recombinants, characterization and expression of cloned DNA, transformation, transgenesis, mutation, molecular mechanism of mutation, site directed mutagenesis, in vitro mutagenesis.

**Unit XI** Polymerase chain reaction (PCR), expression cloning, gel electrophoresis, molecular markers, macromolecule blotting and probing, arrays (DNA array and protein array) – principles and application.

**Practical :** Isolation and purification of DNA and RNA. To check the purity of isolated DNA and RNA. Restriction fragmentation of genomic DNA. Separation of oligos by agarose gel electrophoresis. Southern blotting experiments. Northern blotting experiments. Cloning of DNA fragment in vector. Selection of recombinant. SSR analysis of DNA. cDNA synthesis using RT- PCR. Basic tools in bioinformatics analysis.

**Biochem.-505 Techniques in Biochemistry 2+2 Sem I**

**Unit I** Principles and applications of paper, thin layer, gel filtration, ion-exchange, affinity, column & HPTLC, GC, HPLC and FPLC.

**Unit II** General principles, paper, and gel electrophoresis, native and SDS-PAGE, 2D-PAGE, capillary electrophoresis.

**Unit III** Hydrodynamic methods of separation of biomolecules such as viscosity and sedimentation velocity, - their principles.

**Unit IV** Basic principles of sedimentation, type, care, and safety aspects of centrifuge preparative and analytical centrifugation.

**Unit V** Principles and applications of UV-visible, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X-Ray spectroscopy.

**Unit VI** MS/MS, LC-MS, GC-MS, MALDI-TOF, applications of mass spectrometry in biochemistry.

**Unit VII** Principle, function and instrumentation of atomic absorption spectrophotometry.

**Unit VIII** Principles and applications, light, UV, phase contrast, fluorescence, and electron microscopy, flow cytometry.

**Unit IX** Tracer techniques in biology: concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of α, β and γ emitters, scintillation counters, γ-ray spectrometers, autoradiography, applications of radioactive tracers in biology.

**Unit X** Principles and applications of phosphor imager, MRI, and CT scan.

**Unit XI** Production of antibodies, immunoprecipitation, immunoblotting, immunoassays, RIA and ELISA.

**Unit XII** Cryopreservation, polymerase chain reaction (PCR), FACS.

**Practical :** Expression of concentration in terms of dilution, molarity, normality, percent expression. pH measurement and buffer preparation. Determination of absorption maxima of biomolecules. Estimation of biomolecules through spectrophotometry and other methods. Separation of carbohydrates and amino acids by paper chromatography. Separation and analysis of fatty acids/lipids by GC. Separation/estimation of biomolecules through HPLC and FPLC. Separation of proteins using ion exchange, gel filtration and affinity chromatography. Electrophoretic separation of proteins and nucleic acids. Centrifugation-differential and density gradient. (NH4)2SO4 precipitation and dialysis. Use of radioisotopes in metabolic studies. PCR. ELISA. Western blotting/ Dot blotting.

**Biochem.-506 Immunochemistry** **2+1** **Sem II**

**Unit I** History and scope of immunology, antigens, adjuvants, immune system, organs, tissues and cells, immunoglobulins, molecular organization of immunoglobulin. haptens, Ag-Ab interaction, plant immunity, proteasome mediated process, plantibodies.

**Unit II** Classes of antibodies, antibody diversity, theories of generation of antibody diversity, vaccine, monoclonal and polyclonal antibodies, hybridoma, recombinant antibodies, complement system - classical and alternate.

**Unit III** Cellular interactions in immune response, major histocompatibility complex, cell mediated immune response, cytokines.

**Unit IV** Immunoregulation, immunological tolerance, hypersensitivity, mechanisms of immunity, innate resistance and specific immunity, current immunological techniques – ELISA, RIA, immunoblotting, FACS; basics of PCR and hybridization-based methods of detection, microarray-based detection, multiplexing.

**Practical :** Handling, inoculation, and bleeding of laboratory animals. Preparation of antigens and antisera, natural antibodies. Carbon clearance test. Lymphoid organs of the mouse. Morphology of the blood leucocytes. Separation of lymphocytes from blood, viable lymphocyte count. Antigen-antibody interaction. Precipitation and agglutination. Direct and indirect haemagglutination. Immunoelectrophoresis. Complement fixation. Quantitation of immunoglobulins by zinc sulphate turbidity and single radial immunodiffusion. ELISA. Western blotting. Fluorescent Ab test. Hybridoma technique.

**Biochem.-507 Plant Biochemistry** **2+1** **Sem I**

**Unit I** Structure and function of plant cell and its organelles, phytochromes, chloroplast morphology structure, structure and chemistry of photosynthetic pigments, light reaction of photosynthesis.

**Unit II** Carbon reduction in C3, C4 and CAM plants, photorespiration, sucrose-starch interconversion.

**Unit III** Biosynthesis of structural carbohydrates, storage proteins and lipids.

**Unit IV** Basic concepts of nitrogen and sulphur metabolism: biological nitrogen fixation, nitrate assimilation in plants, sulphur chemistry and function, reductive sulphate assimilation pathway, sulphated compounds.

**Unit V** Biochemistry of seed germination – stages, requirements, metabolism, and mobilization of storage material; Biochemistry of fruit ripening – ripening process, cell wall degrading enzymes, role of ethylene and regulation of ethylene production.

**Unit VI** Different classes of phytohormones, their biosynthesis and mode of action.

**Unit VII** Biochemistry and significance of plant secondary metabolites - phenolics, terpenoids, alkaloids, cyanogenic glycosides and glucosinolates, effect of biotic and abiotic factors on plant metabolism and plant defense system.

**Practical :** Fractionation of cell organelles. Estimation of starch. Assay of ADPG pyrophosphorylase/starch synthase. Assay of PAL/SOD. Assay of PPO/LOX. Estimation of individual amino acids. Qualitative tests of secondary metabolites (alkaloids, sterols etc.). Content and composition of carotenoids, anthocyanin, and chlorophylls. Determination of polyphenols/phenolics. Fractionation of storage proteins. Estimation of glucosinolates. Estimation of cyanogenic compounds.

**Biochem.-508 Animal Biochemistry** **3+0** **Sem II**

**Unit I** Digestion and absorption of food, Detoxification, biochemistry of specialized tissues –connective tissue, skin, muscle, nervous tissue and blood and other body fluids.

**Unit II** Water, electrolyte and acid-base balance, structure, function, and mechanism of major trace elements, vitamins, energy nutrients and biochemistry of respiration, bioactive peptides, and functional oligosaccharides.

**Unit III** Hormones of thyroid, hypothalamus, pituitary, pancreas, adrenals, and sex hormones, Membrane receptors of hormones, signal transduction.

**Unit IV** Immune systems, immunoglobulins, monoclonal antibodies, formation of antibody, antibody diversity, complement system – classical and alternate, major histocompatibility complexes, cell mediated immune response, mechanisms of immunity.

**Biochem.-509 Nutritional Biochemistry** **2+1** **Sem I**

**Unit I** Fundamentals of human nutrition, concept of balanced diet, biochemical composition, energy, and food value of various food grains (including cereals, pulses, oilseeds), fruits and vegetables. Physico-chemical, functional, and nutritional characteristics of carbohydrates, proteins and fats and their interactions (emulsions, gelation, browning etc.). Digestion and absorption, digestive secretions, their characteristic features and control, protection of microflora of the GI tract.

**Unit II** Biochemical functions of nutrients, macro- and micronutrients- carbohydrates, fats and proteins, vitamins, water soluble and fat-soluble vitamins, mineral, and phytonutrients, prebiotics and probiotics, enzymes and metabolic protein factors, cofactor role, electrolytic function, constituents of skeletal tissues, interrelationship in nutrient functions, mineral deficiency diseases; nutraceuticals, antinutritional factors, biochemistry of postharvest storage.

**Unit III** Factors affecting bioavailability of nutrients, biological value of proteins; effect of cooking, processing, and preservation of different food products on nutrients, energy- and micronutrient malnutrition, deficiency diseases of macro and micronutrients.

**Unit IV** Food sensitivity: immunologically mediated food sensitivity, nature, and properties of antigens in foods, mechanism of induction of all allergic reactions, diagnostic tests for food, hypersensitivity, non-immunologically mediated food sensitivity, food sensitivity due to metabolic diseases, gastrointestinal diseases, food additives, pharmacologic agents, food toxins and poisonous and psychological factors.

**Practical :** Estimation of amylose and amylopectin. Estimation of resistant starch. Estimation of ω3, ω6 and trans fatty acid. Estimation of phenols in plant tissue/sample. Estimation of carotenoids. Estimation of amylase, trypsin, and chymotrypsin inhibitor activities. Estimation of Vitamin C in fruits. Estimation of reducing & non reducing sugar in fruits. Estimation of protein contents. Estimation of dietary fibre. Determination of limiting amino acids. Estimation of phytate/ oxalate. Estimation of total antioxidant activity by different methods. Estimation of curcumin.

**Biochem.-510 Nitrogen and Sulphur Metabolism** **2+1** **Sem II**

**Unit I** Nitrogen cycle, assimilation of inorganic nitrogen, nitrate uptake and transporters, enzymology of nitrate reduction - Nitrate reductase (NR) and Nitrite reductase (NiR), NR regulation, nitrate signaling. Assimilation of inorganic nitrogen and N-transport amino acids - glutamine synthetase (GS), glutamate synthase (GOGAT), glutamate dehydrogenase (GDH), aspartate amino transferase (AspT) and asparagine synthetase (AS), interaction between carbon metabolism and amino acid synthesis, biosynthesis of amino acids.

Nitrogen fixation - an overview, enzymology of nitrogen fixation - nitrogenase, nif genes and their regulation, symbiotic nitrogen fixation - biochemical basis of rhizobial infection, nodule development. Mechanism of creation of microaerobic environment for nitrogen fixation. metabolic exchange between host plant and bacteroids.

**Unit II** Overview of sulfate assimilation, sulfur chemistry and function, sulfate uptake and transport, reductive sulfate assimilation pathway, synthesis and function of sulfur containing amino acids, glutathione and its derivatives, role of sulfated compounds in metabolism.

**Practical :** Estimation of nitrite content. Estimation of nitrate content. In vivo assay of nitrate reductase activity. In vitro assay of nitrate reductase activity. In vitro assay of nitrite reductase activity. In vitro assay of glutamine synthetase activity. In vitro assay of glutamate synthase and glutamate dehydrogenase activity. Estimation of ureides and amides. Assay of nitrogenase activity by acetylene reduction method. Estimation of hydrogen evolution by legume nodules. Estimation of cysteine, methionine, pyruvate, and glutathione. Assay of APS activity.

**Biochem.-511 Biochemistry of Xenobiotics** **2+0** **Sem I**

**Unit I** Xenobiotics: classification and their effects on biological systems, Problems related to xenobiotics degradation, potential effects of toxic agents on immune system function, biotic metabolism of xenobiotics - biodegradation/biotransformation.

**Unit II** Mode of degradation - Enzymatic and Non-enzymatic, Metabolism of toxic compounds with reference to role of detoxifying enzymes, Mechanism of xenobiotics detoxification – in animal using the enzymes of Phase I and Phase II, Role of microbes in xenobiotics degradation and co-metabolism, Biodegradation and its genetics, manipulation of xenobiotic degradative genes.

**Unit III** Plant metabolism of xenobiotics - transformation, conjugation, and compartmentation, Metabolic responses of pesticides in plants, Impact, metabolism, and toxicity of heavy metals in plants, Regulation of xenobiotics in higher plants: signalling and detoxification.

**Unit IV** Phytoremediation, Advances in development of transgenic plants for remediation of xenobiotic pollutants, safety assessment of xenobiotics.

**Biochem.-591 Seminar** **1+0**

**Biochem.-599 Master's Research** **0+30**

## Ph.D. courses

**Biochem.-601 Advanced Enzymology** **2+1** **Sem II**

**Unit I** Theory of enzymatic catalysis, Specificity and editing mechanisms, concept of active site and enzyme substrate complex, active site mapping, factors associated with catalytic efficiency, mechanism of enzyme reactions, detection of intermediates in enzymatic reactions.

**Unit II** Transition state theory, Arrhenius equation, Determination of energy of activation, effect of pH and temperature on enzyme kinetics, pre-steady state and steady state kinetics, single substrate kinetics, allosteric enzymes and mixed inhibition, substrate and product inhibition, numerical exercises.

**Unit III** Mechanism determination by radioisotope exchange, role of enzymes in regulation of metabolism, bifunctional enzymes, pseudoenzyme and enzyme promiscuity, extremozymes, catalytic nucleic acids (ribozymes, catalytic DNA).

**Unit IV** Advantages and disadvantages of biocatalysis in technology driven processes, stabilization and regeneration of enzyme systems used in biotechnology, protein engineering of enzymes, creation of chimeric, bifunctional, immobilization of enzymes, semisynthetic enzymes and their use as industrial biocatalysts, and their practical significance, modern information technologies in enzyme engineering.

**Practical :** Purification and characterization of some model enzymes (peroxidise, α-amylase, lipase). Study kinetics of inhibited and uninhibited enzyme catalysed reactions. Determination of Km values of single substrate reactions. Determination of enzyme activity by coupled assay. Electrophoretic separation of isozymes. Enzyme immobilization.

**Biochem.-602 Advanced Molecular Biology** **3+0** **Sem II**

**Unit I** Genes, their relationship with chromosomes, gene number hypothesis; Genome – definition, variation and organization in plants and animals, structure of organelle genomes; concept of epigenome, genome size and genome evolution.

**Unit II** Prokaryotic and eukaryotic gene regulation, transcriptional and posttranscriptional regulation. regulation at genome level, role of histones, riboswitches.

**Unit III** Genome sequencing technologies, Sanger sequencing, next generation sequencing, nanopore sequencing; genome mapping – genetic map construction, physical mapping.

**Unit IV** Methods of gene isolation and transfer in plants and animals, agrobacterium mediated and direct transfer of genes in plants and animals; gene silencing technologies: virus induced gene silencing, RNA interface; genome editing -TALENs, CRISPR/cas, ZFN and their application, site directed mutagenesis, Application of genetic engineering in different fields, gene therapy.

**Unit V** Genome browsing, primer design, marker application for breeding, application of MAS in case studies. Bioethics and bio safety guidelines, IPR in recombinant DNA research.

**Biochem.-603 Biochemistry of Biotic and Abiotic Stresses** **3+0** **Sem I**

**Unit I** Molecular mechanisms of fungal and bacterial infection in plants; changes in metabolism, cell wall composition and vascular transport in diseased plants.

**Unit II** Role of secondary metabolites, Plant defence response, antimicrobial molecules; genes for resistance, hypersensitive response and cell death; systemic and acquired resistance, pathogen derived resistance.

**Unit III** Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination; viroids.

**Unit IV** Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation.

**Unit V** Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes of defense system. Role of calcium, nitric oxide, and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

**Biochem.-604 Frontier Topics in Biochemistry** **2+0** **Sem II**

**Unit I** Latest development in metabolic nutrition.

**Unit II** Latest development in environmental and industrial biochemistry.

**Unit III** Latest development in molecular biology techniques.

**Unit IV** Latest development in metabolic engineering.

**Unit V** Latest development in regulation of gene expression.

**Unit VI** Latest development in biotic and abiotic stress response in plants.

**Unit VII** Latest development in protein chemistry.

**Unit VIII** Topics related to recent approaches concerning application of biochemical tools and techniques.

**Biochem.-605 Concepts and Applications of Omics in Biological Science 3+0 Sem I**

**Unit I** Various methods of sequencing including automated sequencing and microarrays, whole genome sequence analysis.

**Unit II** Comparative genomics, functional genomics, nutrigenomics, transcriptomics, gene identification, gene annotation, pairwise and multiple alignments, application of genomics, quantitative PCR, SAGE, MPSS, microarray, role of bioinformatics in functional genomics.

**Unit III** 2D-PAGE, MSMS, MALDI-TOF, comparative proteomics and structural proteomics.

**Unit IV** Elucidation of metabolic pathways, Sample preparation for metabolomics. Techniques involved in metabolite identification- LCMS, NMR, FTIR, MS. Metabolomics in biotic and abiotic stress in crop plants, SPE, SPME, metabolic pathway engineering and its application, Concept and application of ionome and ionomics.

**Biochem.-606 Biomembranes 2+0 Sem II**

**Unit I** Concept of biomembranes and their classification based on cellular organelles. Physico-chemical properties of different biological and artificial membranes. Cell surface receptors and antigen.

**Unit II** Membrane biogenesis and differentiation; membrane components-lipids, their distribution and organization; proteins, intrinsic and extrinsic, their arrangement. carbohydrates in membranes and their function.

**Unit III** Various membrane movements; Membrane transport: Organization of transport at plant membranes, pumps, carriers, ion channels, water transport through aquaporins, transport of macro molecules: exocytosis and endocytosis, energy transduction.

**Unit IV** Role of membrane in cellular metabolism, cell recognition and cell-to-cell interaction; signal transduction, recent trends and tools in membrane research.

**Biochem.-607 Application of Techniques in Biochemistry 1+2 Sem I**

**Unit I** Isolation and purification of important metabolites from microbial/plant/animal source, Applications of paper, thin layer and gas liquid chromatography, PAGE, FPLC and HPLC in the separation of biomolecules. Determination of molecular weight of protein using PAGE/ gel filtration method.

**Unit II** Electrophoretic separation of protein, Experiments on DNA: Isolation, agarose gel electrophoresis and restriction analysis of DNA. Techniques in DNA-protein and protein-protein interaction.

**Unit III** Isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation.

**Unit IV** Isolation, purification, and characterization of enzymes, isozymic analysis and enzyme immobilization.

**Unit V** Application of PCR, yeast 2 hybrid system, Antigen-Antibody interaction, ELISA, Chromatin immunoprecipitation, gel based and gel free proteasome tools.

**Practical :** Isolation and purification of important metabolites from microbial/plant/animal source. Paper chromatography and thin layer chromatography. gas liquid chromatography. PAGE. FPLC and HPLC. Determination of molecular weight of protein using PAGE/ gel filtration method. Electrophoretic separation of protein. Isolation, agarose gel electrophoresis and restriction analysis of DNA. Techniques in DNA-protein and protein-protein interaction. Isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation. Isolation, purification, and characterization of enzymes. isozymic analysis. enzyme Immobilization. PCR. yeast 2 hybrid system. Antigen-Antibody interaction. ELISA. Chromatin immunoprecipitation. Gel based and gel free proteasome tools.

**Biochem.-691 Seminar I 1+0**

**Biochem.-692 Seminar II 1+0**

**Biochem.-699 Ph.D Research 0+75**

# BOTANY

## PROGRAMMES

**M.Sc.**
**Ph.D.**
**Five Year Integrated M.Sc. (Hons.)**

## COURSE REQUIREMENT

### M.Sc.

| | |
|---|---|
| Field of Specialization | Plant Physiology, Biosystematics |
| Required Courses | Bot.-501, Bot.-502, Bot.-503, Bot.-504, Bot.-509, Bot.-511 |
| Supporting Courses | Stat.-502 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Minor Fields | Biochemistry, Biotechnology, Horticulture, Microbiology, Plant Breeding and Genetics, Plant Pathology, Vegetable Crops, Forestry or any other as approved by the Dean Postgraduate Studies. |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |

### Ph.D.

| | |
|---|---|
| Field of Specialization | Plant Physiology, Biosystematics |
| Required Courses | Bot.-601, Bot.-602, Bot.-603, Bot.- 604, Bot.- 606 |
| Supporting Courses | Courses from subject matter fields/other than Minor relating to area of special interest and research problem. |
| Minor Fields | Biochemistry, Biotechnology, Horticulture, Microbiology, Plant Breeding and Genetics, Plant Pathology, Vegetable Crops, Forestry or any other as approved by the Dean Postgraduate Studies |
| Deficiency Courses | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Five Year Integrated M.Sc. (Hons.)

| | |
|---|---|
| Field of Specialization | Plant Physiology, Biosystematics |
| Required Courses | All courses listed for Semester I to VI and Bot.-501, Bot.-502, Bot.-503, Bot.-504, Bot.-509, Bot.-511 |
| Supporting Courses | Stat.-502 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Minor Fields | Biochemistry, Biotechnology, Horticulture, Microbiology, Plant Breeding and Genetics, Plant Pathology, Vegetable Crops Forestry or any other as approved by the Dean Postgraduate Studies. |
| Deficiency Courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |

# DESCRIPTION OF COURSE CONTENTS

**Bot. 51 Agricultural Botany** **1+1** **Sem I**

An introduction to plant kingdom. Morphological features of a flowering plant. Structure of root and stem and their various modifications. Parts of leaf, simple and compound leaf, phyllotaxy, venation and modifications of leaf. Types of inflorescence and fruits. Reproductive system in flowering plants- flower morphology, pollination and double fertilization. Structure of monocot and dicot seed. Types of seed germination. Characteristic features and economic importance of families- Brassicaceae, Cucurbitaceae, Papilionaceae, Malvaceae, Rutaceae, Solanaceae and Poaceae. A brief account of interaction of plants with environment.

**Practical :** Study of one specimen from each group of plant kingdom. Morphology of root and stem and their modifications. Parts of leaf, types of leaf, phyllotaxy, venation and modifications of leaf. Racemose, cymose and special types of inflorescence. Different types of fruits. Structure of monocot and dicot seed. Epigeal and hypogeal germination. Study of one specimen from each of the above mentioned families.

**Bot. 91 Basic Plant Physiology** **3+1** **Sem II**

Plant water relations-diffusion, imbibition, osmosis, plasmolysis, water potential; transport in plants: movement of water, gases and nutrients; cell to cell transport- diffusion, facilitated diffusion, active transport long distance transport of water- absorption, apoplast, symplast, transpiration pull, root pressure and guttation; opening and closing of stomata uptake and translocation of mineral nutrients; transport of food; phloem transport, mass flow hypothesis mineral nutrition- essential minerals, macro and micronutrients and their role; deficiency symptoms; mineral toxicity; elementary idea of hydroponics as a method to study mineral nutrition nitrogen metabolism- nitrogen cycle, biological nitrogen fixation photosynthesis- site of photosynthesis, pigments involved in photosynthesis (elementary idea); photochemical (cyclic and non cyclic photophosphorylation) and biosynthetic phases ($C_3$, $C_4$ and cam pathways) of photosynthesis, factors affecting photosynthesis respiration- exchange of gases; cellular respiration - glycolysis, fermentation (anaerobic),TCA cycle and electron transport system (aerobic); energy relations - number of atp molecules generated; respiratory quotient plant growth and development- phases of plant growth and plant growth rate; conditions of growth; differentiation, dedifferentiation and redifferentiation seed germination; factors affecting germination and seed dormancy, types of dormancy and factors affecting it phytohormones- auxin, gibberellin, cytokinin, ethylene, ABA brief account of senescence, photoperiodism and vernalization.

**Practical :** Study of processes of diffusion, osmosis, imbibition and plasmolysis. Measurement of water status of root, stem and leaf. Demonstration of phenomenon of transpiration. Study of distribution of stomata in upper and lower surface of leaves. Comparative study of the rate of transpiration in upper and lower surface of leaves. Study of role of factors affecting photosynthesis. Study of aerobic and anaerobic respiration. Study of mineral deficiency symptoms in various field crops. Study of seedling growth pattern. Study of seed germination and dormancy. Physiological applications of phytohormones.

**Bot. 92 Plant Reproduction and Biotechnology** **3+1** **Sem II**

Modes of reproduction- asexual and sexual, binary fission, sporulation, budding, fragmentation, vegetative propagation Sexual reproduction in flowering plants Development of male and female gametophytes; Pollination-types, agencies and examples; Outbreeding devices; pollen-pistil interaction Double fertilization; Post fertilization events- development of embryo and endosperm Development of seed and fruit formation and significance of seed and fruit formation Special modes-apomixis, parthenocarpy, polyembryony Principles and process of biotechnology; Genetic engineering (recombinant DNA technology) Application of biotechnology in agriculture; Gene therapy; Genetically modified organisms- Bt crops; Biosafety issues- biopiracy and patents.

**Practical :** Exercise on controlled pollination- emasculation, tagging and bagging. Study of pollen grains of different plants by making slides. Comparative study of various flowers adapted to pollination by different agencies (wind, insects).

**Bot. 101 Basic Botany** **2+1 Sem. I**

Plant kingdom and features of each group; Morphology, modifications and functions of root, stem, leaf, flower and inflorescence; Pollination and fertilization; Fruit types; Structure of dicot and monocot seed, seed germination. Cell structure; DNA, chromosome and genes; Cell and tissue types; Internal structure of root, stem and leaf. Plant taxonomy, systems of classification; Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

**Practical** : Description of one plant species from each group of plant kingdom; Study of morphology and modifications of root, stem, leaf, flower; Types of inflorescence; Structure of various types of seeds and fruits; Demonstration of cell structure, tissue types; Structure of monocot and dicot root, stem and leaf; One flower from each family.

**Bot. 104 Fundamentals of Crop Physiology** **1+1 Sem. II**

Introduction to crop physiology and its importance in agriculture. Plant cell-an overview. Diffusion and osmosis, absorption of water, transpiration and stomatal physiology. Mineral nutrition of plants-functions and deficiency symptoms of nutrients, nutrient uptake mechanisms. Photosynthesis-light and dark reactions, $C_3$, $C_4$ and CAM plants. Respiration-glycolysis, TCA cycle and electron transport chain. Fat Metabolism-fatty acid synthesis and breakdown. Plant growth regulators- physiological roles and agricultural uses. Physiological aspects of growth and development of major crops. Growth analysis, role of physiological growth parameters in crop productivity.

**Practical :** Study of plant cells. Structure and distribution of stomata, imbibition, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, estimation of tissue relative water content. Separation of photosynthetic pigments through paper chromatography, demonstration of rates of photosynthesis and respiration. Tissue test for estimation of mineral nutrients, demonstration of deficiency symptoms of mineral nutrients in plants. Measurement of photosynthetic $CO_2$ assimilation by infra red gas analyser (IRGA).

**Bot. 201 Plant Physiology** **2+1 Sem. I**

Plant physiology- scope in agriculture. Osmosis, imbibition, water absorption, water translocation and transpiration. Stomatal mechanisms. Physiological role and deficiency symptoms of major and minor elements. Absorption and translocation of minerals. Concepts of photosynthesis, photorespiration and translocation of photoassimilates. Respiration. Dynamics of growth. Stress physiology. Nitrogen and sulphur metabolism. Plant growth regulators - biosynthesis and physiological roles. Seed germination and dormancy. Senescence and abscission. Vernalization.

**Practical** : Demonstration of processes of diffusion, osmosis, imbibition and plasmolysis. Ascent of sap, transpiration. Nutrient deficiency symptoms in crop plants. Plant growth analysis. Quantitative and qualitative estimation of plant pigments. Experiments on photosynthesis and respiration. Effects of plant growth regulators on growth and seed germination. Experiments on seed dormancy. Estimation of relative water content and plant water potential. Proline estimation.

**Bot. 202 Plant Morphology** **3+0 Sem.I**

Morphology, modifications and functions of root, stem and leaf. Inflorescence types, definition of flower, origin of floral leaves, tendencies in the evolution of the flower, floral anatomy of dicot and monocot flower, morphology of calyx and corolla, structure and morphological nature of stamen, staminodes; morphology of the carpel; vasculature and interpretation of inferior ovary; types of placentation; form, orientation and the nature of ovule; evolutionary relationship of fruit types; detailed morphology of important crop plants: cereals, pulses, fibre crops and oilseeds.

**Bot. 203 Systematic Botany** **3+0 Sem.II**

History of plant taxonomy, modern systems of classification; principles of taxonomy; international rules of nomenclature; botanical gardens and herbaria; General account of floral variation, evolutionary affinities and economic importance of representative families of various orders of the series: Thalamiflorae, Disciflorae, Calyciflorae, Inferae, Heteromerae, Curvembryeae, Multiovulatae aquaticae, Multiovulatae terrestris,

Microembryeae, Daphnales, Achlamydosporeae, Unisexuales and Ordines anomali. Evolution of families from the series: Microspermae, Epigynae, Coronarieae, Calycinae, Nudiflorae, Apocarpeae and Glumaceae.

**Bot. 204 Plant Histology** **2+0** **Sem.I**

Ultrastructure of cell and its inclusions; cell wall organization and its growth; tissues and tissue systems; shoot and root apical meristems and vascular cambium; anatomy of root, stem, leaf and flower; secondary growth and anomalous secondary growth; distribution of mechanical tissues in plants; galls and tumours; applications of plant anatomy.

**Bot. 205 Botany of Economic Plants** **2+0** **Sem.I**

Recent trends and scope of economic botany; Botanical description and commercial products of major categories of food plants (cereals, millets, pulses, nuts, vegetables and fruits) , sugar producing plants, oils (essential and edible oils, fatty oils), beverage-, fibres-, latex- (rubber and other latex products), paper and medicinal plants (drugs obtained from various plant parts), biofuels.

**Bot. 301 Fundamentals of Plant Physiology** **3+0** **Sem.II**

Plant physiology, its scope in agriculture. Structure and functions of cell organelles; osmosis, imbibition, water absorption, water translocation and transpiration; stomatal mechanisms; source, physiological role and deficiency symptoms of major and minor elements, absorption and translocation of minerals and cell sap; concepts of photosynthesis and respiration, photorespiration, water culture technique; processes involved in growth and development; plant growth regulators: occurrence, biosynthesis, mode of action and commercial applications.

**Bot. 302 Basic Experiments in Botany** **0+3** **Sem.I**

Description of plant species from each family in technical terms, study of morphology of different plant parts viz., root, stem and leaf; floral biology of important plants; study of cells and tissues by hand sectioning and maceration; study of anatomical structures in longitudinal and transverse sections of root, stem and leaf. Study of cell, cytoplasm and nucleus; demonstration of processes of osmosis, imbibition, plasmolysis; role of factors affecting photosynthesis and respiration; deficiency symptoms of nutrients in crop plants; processes involved in growth and development.

**Bot. 303 Algae, Fungi and Lichens** **2+1** **Sem.I**

**I**ntroduction, classification, comparative morphology, reproduction, perennation; economic importance; interrelationships and evolutionary tendencies of algae; structure, reproduction and life cycle of algal species belonging to the different groups viz., Cyanophyta, Chlorophyta, Xanthophyta, Chrysophyta, Euglenophyta, Phaeophyta and Rhodophyta. Nomenclature and classification of fungi belonging to classes Phycomycetes, Ascomycetes, Basidiomycetes and Fungi Imperfecti; general characteristics and life cycles of important genera of fungi and lichens.

**Practical :** Study of the morphology of different algae and fungi, monographic study of some important algae and fungi.

**Bot. 304 Bryophyta** **2+1** **Sem.II**

Introduction, classification, origin and economic importance of bryophytes, their ecology and distribution. Hepaticeae and Anthocerotae: General characters and classification, gametophytes of thalloid and leafy liverworts. Asexual reproduction, sporophytes of liverworts. General account of Anthocerotae and their evolutionary tendencies. Musci: General characters and classification, range of gametophyte structure, asexual and sexual reproduction, sporophyte and alternation of generation; origin and evolution of sporophyte; geographical distribution; cytogenetics and speciation.

**Practical:** Study of representative types belonging to different groups.

**Bot. 305 Pteridophyta** **2+1** **Sem.II**

Introduction; general features; classification; life cycle and alternation of generation; salient features of different groups like Psilophyta, Lycophyta, Sphenophyta and Pterophyta. Study of life histories of following important genera e.g. *Selaginella, Psilotum, Lycopodium, Isoetes, Equisetum, Ophioglossum, Dryopteris,*

*Marsilea, Azolla* and *Salvinia*. Origin of Pteridophyta, apogamy and apospory; steler system, telome theory and evolution of sporophyte; heterospory and seed habit, gametophytes of pteriodophytes; fossil pteriodophytes.

**Practical :** Study of representative types belonging to different groups.

**Bot. 306 Gymnosperms** **2+1** **Sem.II**

General description; differences between gymnosperms, higher cryptogams and angiosperms; classification of gymnosperms; detailed study and life cycle of *Gingko, Cycas, Biota, Pinus, Ephedra, Gnetum, Welwitschia, Juniperus* and *Cupressus*; process of fossilization.

**Practical :** Study of morphology, anatomy and reproduction of important genera pertaining to above. Examination of fossil slides.

**Bot. 307 Plant Biodiversity and Environment** **2+1** **Sem.I**

Concepts of biodiversity, conservation and protection of biodiversity for its suitable utilization; agro-biodiversity and its missions. Diversification of cropping system; introduction of herbal crops in Punjab; vulnerability and extinction of species; endangered species in various ecosystems; use of plant species to check deforestation and desertification; germplasm banks. Response of plants to environmental stresses, green house effect, environmental pollution, pollution of soil and water bodies.

**Practical :** Plant survey methods; excursions and field visits. Effect of environmental factors on plant growth, assimilation rate and biomass partitioning.

**Bot. 401 Plant Physiology-I (Plant Water Relations and Mineral Nutrition)** **2+1** **Sem.II**

Plant cell, membranes, cell organelles; properties of water; osmotic potential, water potential, pressure potential and their relationships; soil water, absorption and translocation of water; plasmolysis, imbibition, stomatal mechanisms, factors affecting water loss, wilting, drought resistance; essential elements: physiological functions and deficiency symptoms of macro and microelements. Mechanism of mineral absorption, factors affecting mineral absorption; microorganisms in relation to nutrient acquisition, nutrient use efficiency. Nutrients in metabolism and disease tolerance.

**Practical :** Cell structure; preparation of solutions. Demonstrations of processes of diffusion, osmosis, imbibition and plasmolysis; measurements of water potential, membrane permeability, root pressure, guttation, ascent of water, transpiration.; deficiency symptoms of nutrients in crop plants; phloem mobility; cation exchange capacity in plant species.

**Bot. 402 Plant Physiology-II (Plant Metabolism)** **2+1** **Sem.II**

Photosynthesis; plant pigments, photosystems, light and dark reactions in C3, C4 and CAM plants; respiration, glycolysis, Pentose Phosphate Pathway, citric acid cycle, electron transport chain; photorespiration and its significance in plant productivity; secondary metabolites and plant defense systems.

**Practical :** Characterization of pigments; determination of Hill reaction activity; experiments on photosynthesis and respiration.

**Bot. 403 Plant Physiology-III (Growth, Differentiation and Morphogenesis)** **2+1** **Sem.II**

Mechanics of growth and differentiation in plants; factors affecting growth and differentiation; Plant growth regulators (growth promoters, inhibitors and retardants); photoperiodism and vernalization; physiology of seed formation, maturation, dormancy and germination; fruit ripening. Senescence and programmed cell death. Brief account of morphogenesis; polarity, symmetry, regeneration, tissue culture and abnormal growth. Effect of light, water, temperature and growth on morphogenesis.

**Practical** : Sigmoid growth curve, bioassays of plant growth regulators, their effects on seed germination and plant growth. Experiments on seed dormancy, senescence and fruit ripening.

## Postgraduate Courses

**Bot.-501/ PP-501 Principles of Plant Physiology I - Plant Water Relations and Mineral Nutrition** **2+1 Sem. I**

**Unit I** Water and its importance; Molecular structure of water; Properties and functions of water, Concept of water potential; Plant cell and soil water potential and their components; Methods to determine cell and soil water potential;Concept of osmosis and diffusion, Soil physical properties and water availability in different soils; Water holding capacity and approaches to improve WHC; Concept of FC and PWP; Water holding polymers and their relevance.

**Unit II** Root structure and functions; Root architecture and relevance in water mining; Mechanism of water absorption and translocation; Theories explaining water absorption and translocation;Aquaporins, Mycorrhizal association and its relevance in watermining.

**Unit III** Evaporation and transpiration; relevance of transpiration; factors regulating transpiration; Measurement of transpiration; approaches to minimize evaporation and transpiration; Concept of CCATD and its relevance, Energy balance: Solar energy input and output at crop canopy level, Stomata-its structure, functions and distribution; Molecular mechanisms of stomatal opening and closing; Concept of guard cell turgidity; role of K and other osmolytes; role of ABA in stomatal closure; Guard cells response to environmental signals; Signaling cascade associated with stomatal opening and closure, Antitranspirants and their relevance in Agriculture.

**Unit IV** WUE and its relevance in water productivity; Transpiration efficiency, a measure of intrinsic WUE; Approaches to measure WUE; Stomatal and mesophyll regulation on WUE; Passioura's yield model emphasizing WUE.

**Unit V** Physiology of water stress in plants; Effect of moisture stress at molecular, cellular, organ and plant level, Drought indices and drought tolerance strategies, Drought tolerance traits.

**Unit VI** Role of mineral nutrients in plant metabolism; Essential elements and their classification; Beneficial elements; factors influencing the nutrients availability; Critical levels of nutrients, Functions of mineral elements in plants, Deficiency and toxicity symptoms in plants.

**Unit VII** Mechanism of mineral uptake and translocation; Ion transporters; genes encoding for ion transporters; localization of transporters; xylem and phloem mobility; Nutrient transport to grains at maturity; Strategies to acquire and transport minerals under deficient levels, Role of mycorrhiza, root exudates and PGPRs in plant nutrient acquisition.

**Unit VIII** Foliar nutrition; significance and factors affecting total uptake of minerals; Foliar nutrient droplet size for effective entry; Role of wetting agents in entry of nutrients.

**Practical :** Standard solutions and preparation of different forms of solutions. Studies on the basic properties of water. Demonstration of surface tension of water and other solvents. Measurement of plant water status: Relative water content and rate of waterloss. Determination of water potential through tissue volume and Chardakov's test. Determination of water potential using pressure bomb, osmometer, psychrometer. Determination of soil moisture content and soil water potential. Use of soil moisture probes and soil moisture sensors. Measurement of transpiration rate in plants; use of porometry. Measurement of CCATD and its relevance. Demonstration and use of anti-transpirants to reduce transpiration. Influence of potassium and ABA onstomatal opening and closing respectively. Deficiency and toxicity symptoms of nutrients. Effect of water stress on plant growth and development.

**Bot.-502 Plant Anatomy and Embryology** **2+1 Sem. I**

**Unit I** Modular, tissue and cellular organization of plant body, Differentiation, totipotency and morphogenesis, Ultrastructure of plant cell, development of cell wall; tissues - their ontogeny in relation to functional specialization, transfer cells, Cell types of xylem and phloem, Basic structure of secondary xylem and phloem.

**Unit II** Classification of meristems, Root and shoot apical meristem, Origin of leaves and branches, Origin and organization of cambium, Structure and development of stem, root and leaf, stomata and secretory tissues, Development of periderm, morphology of periderm and rhytidome, structure of autumn and spring wood and unusual secondary growth.

**Unit III** Structure of flower: normal and abnormal anther and stigma, Mega and microsporogenesis; embryo sac, endosperm development, Pollen pistil interactions and self incompatibility, Process of fertilization.

**Unit IV** Embryo development, polyembryony, parthenogenesis, parthenocarpy, Abscission, healing of wounds and union of grafts; Application of applied plant anatomy and embryology in crop improvement.

**Practical :** Study of structure of parenchyma, collenchyma, sclerenchyma. Study of the component cells of xylem and phloem. Study of structure of transfer cells and laticifers. Study of the types of stomata and make temporary and permanent slides. Study of the epidermal glands in different plant samples. Observing the structure and organization of shoot apex and root apex. Observing the origin of cambium during secondary growth. Study of anomalous secondary growth in stem, root and leaf samples.

**Bot.-503 Taxonomy and Biosystematics 2+1 Sem. I**

**Unit I** Principles of Taxonomy, Hierarchy of classification, Artificial, Phylogenetic and Modern system of classification, Binomial nomenclature, Principles of International code of Botanical Nomenclature, Numerical Taxonomy.

**Unit II** Herbarium, Specimen preparation for Herbarium, Virtual Herbarium, Botanical garden, Floristic,Botanical survey of India.

**Unit III** Taxonomy and Biosystematics, Biosystematic categories, Structural, biochemical and molecular systematic,Plasticity of phenotype and phenotypic variability,Plant geography, sympatric and allopatric taxa, adaptive radiations, Ecological properties of a species, patterns of ecotypic differentiation, Ecotypes in agriculture and forestry,Isolating mechanisms, Abrupt and general speciation mechanisms, speciation in vegetatively reproducing plants, Breeding systems, their taxonomic and evolutionary significance,Self and inter-specific incompatibility.

**Unit IV** Descriptive terminology of flowering plants: Magnoliaceae, Papaveraceae, Brassicaceae, Malvaceae, Rutaceae, Meliaceae, Fabaceae, Rosaceae, Myrtaceae Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Solanaceae, Scrophulariaceae, Lamiaceae, Chenopodiaceae, Euphorbiaceae, Orchidaceae, Musaceae, Zingiberaceae, Amaryllidaceae, Liliaceae, Arecaceae, Araceae, Cyperaceae and Poaceae.

**Unit V** Plant and civilization, Centre of origin and gene diversity, Description, utilization, cultivation and improvement of economically important plants: Food plants (cereals, millets, pulses, fruits, vegetables, sugar and oil plants). Drug yielding plants, Fibre yielding plants, Industrial use plants (dyes, waxes, tannins), Unexploited plants of potential economic value, plants as a source of renewable energy.

**Practical :** Description and identification of the plants belonging to the following families: Magnoliaceae, Papaveraceae, Brassicaceae, Malvaceae, Rutaceae, Meliaceae, Fabaceae, Rosaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Solanaceae, Scrophulariaceae, Lamiaceae, Chenopodiaceae, Euphorbiaceae, Orchidaceae, Musaceae, Zingiberaceae, Amaryllidaceae, Liliaceae, Arecaceae, Araceae, Cyperaceae and Poaceae. Study and identification of economically important plants and their products: Food plants (cereals, legumes, oilseeds, fruits, vegetables, etc.), Medicinal plants (atropa, cinchona, digitalis, rauwolfia, etc.), Industrial product yielding plants (Paper, dyes, waxes, gums, etc.), Fibre yielding plants (cotton, flax, hemp, jute, senn, sisal, coconut, etc.).

**Bot.-504 Plant Ecology 2+1 Sem. II**

**Unit I** Concept of ecology, autecology, synecology, flow of energy in ecosystem, food chain and food web, Concept of ecological pyramids, Ecosystem and Biome, Components of ecosystem, Types of ecosystem, Dynamics of ecosystems, Biogeochemical cycles in ecosystem, Economic importance of microbes, plants and animals.

**Unit II** Types of ecological succession, Causes and trends of succession, Hydrosere, lithosere, Climax concept in succession.

**Unit III** Global warming and ozone depletion, Environment monitoring, Remote sensing and geographic information system, environmental impact assessment, sustainable development, Concept of pollution and pollutants, primary and secondary pollutants, Types of pollution (air, water, soil, noise and radioactive

pollution), Causes and effects of different types of pollution, Measures to control or minimise pollution, Biomedical waste, e-waste.

**Unit IV** Ecological groups of plants and their adaptations on the basis of their distribution, temperature and water etc.

**Practical :** Experiments on community structure and dynamics, floristic composition, succession, Experiments on pollution, Remote sensing of agriculture and ecosystem.

**Bot.-505/PP-503 Plant developmental Biology: Physiological and Molecular Basis 2+0 Sem II**

**Unit I** Principles and methods of genetic engineering and recombinant DNA technology, Allopheny, Gene transfer methods in plant, Genetic engineering for photosynthesis, Genetic engineering to enhance nitrogen fixation, Genetic engineering for manipulation of seed reserves, Unit II-Molecular Techniques used for identification of genetically engineered plants, Polymerase chain reaction, Blotting technique, Molecular probes, ELISA.

**Unit II** Introduction and history of plant tissue culture, Concept of cellular totipotency, cytodifferentiation and organogenic differentiation and regeneration, somatic embryogenesis, cell lines and cell clones, Nutrition medium and sterilization techniques, Various types of plant tissue culture (callus culture, shoot bud culture, embryo culture, etc.), Rapid plant propagation (Micropropagation) by tissue culture, *In vitro* approaches for the genetic manipulation of plants, Protoplast culture, Somatic hybridization, hybrid and cybrid production, Haploid plant production, Artificial seeds, Pre-fertilization treatments of pollen for directed genetic change, in vitro manipulation of ovule tissues.

**Unit III** Hybridoma technology, Germplasm maintenance and storage, Prospects of Plant Biotechnology in crop improvement, Growth regulators in relation to plant productivity, Molecular farming, Omics technologies and their applications.

**Bot.-506 Histochemistry and Plant Ultrastructure 1+1 Sem. II**

**Unit I** Introduction and principles of histochemistry and cytochemistry, Botanical microtechniques, Stains and staining procedures, Microscopy, various types of microscopy, principles of light and electron microscopes and micrometry, General information on plant anatomy and the role of various cell inclusions in plant system, Histochemical procedures for localization of reserve substances like polysaccharides, lipids, proteins and nucleic acids, Histological localization of important enzymes in plant tissues, Histochemical analysis of some plant processes like abscission, reproductive development, stomatal movement, etc.

**Unit II** Ultrastructure of plant cell membrane and cell wall, Ultrastructure of cell organelles like nucleus, endoplasmic reticulum, etc. existing in plant cell, Ultrastructure of meristematic cells; phloem, cambium, guard cells, embryo sac, etc., Role of histochemistry in collation of structure with function.

**Practical :** Processing of plant material for microtome sectioning. Preparation of slides. Histochemical localization of reserve substances and enzymes in plant cells/tissues in hand sections and microtome sections.

**Bot.-507 Plant Biodiversity and Environmental Conservation 1+1 Sem. II**

**Unit I** Diverse Vegetation of India, Mission and concerns of biodiversity.

**Unit II** Types of Conservation, In situ and Ex situ Conservation, Levels of biodiversity, keystone species, Measuring biodiversity-alpha, beta & gamma biodiversity, Causes of extinction Endangered, vulnerable species, IUCN Red list categories, Protection of biodiversity, Biosphere Reserves, National and Biodiversity Parks, Hot spots in India, Gene banks, Convention of Biological diversity (CBD).

**Unit III** Study of herbal crops of Punjab like Neem, Tulsi, Moringa, Gloe, Amla, Aloe, Turmeric, Onion, Garlic, Malathi, Saunf, Methi etc.

**Unit IV** Sources and effect of Water Pollution, Assessment of water quality- biochemical oxygen demand (BOD), Algal Bloom and Eutrophication.

**Practical :** Plant survey methods. Plant diversity at PAU campus. Diversity in medicinal herbs, shrubs and trees. Diversity in ornamental and field visits.

**Bot.-508 Plant Morphogenesis** **2+1** **Sem. II**

**Unit I** Introduction, Vegetative development, Reproductive development, Cellular polarity, Regulation of cell and tissue dimension, pattern formation and cellular differentiation.

**Unit II** Distinct zones and layers, Auxin and SAM formation, KNOX genes, cytokinins and GA levels in the regulation SAM, Apical dominance and phase change.

**Unit III** Establishment of leaf polarity, Adaxial and abaxial polarity, Blade outgrowth, Proximal and Distal Polarity, KNOX genes and leaflet formation.

**Unit IV** Developmental zones of root origin of different root tissues, Cellular identity, Auxin and maintenance of RAM, Cytokinins and root development, Root hair, stomata and trichome development.

**Unit V** Origin of different types of floral-organ, Gene regulation of floral development, ABC model of floral organ identity.

**Unit VI** Seed Development -Endosperm development , Coenocytic endosperm and its cellularization, aleurone layer differentiation, Seed coat development, Seed maturation , LEA proteins and abscisic acid, Fruit development and ripening- changes in color, taste and flavor of fruit, fruit softening , climacteric and non-climacteric fruits.

**Unit VII** Elements of cellular transduction in relation to differentiation in plants, Programmed cell death, Totipotency, *In vitro* regulation of differentiation and development in higher plants.

**Unit VIII** Plant responses to light, phytochrome and its signaling pathway, phototropins, Blue light Responses and Photoreceptors, cryptochrome.

**Practical :** Effect of light, temperature and plant growth regulators on cellular differentiation and organogenesis.

**Bot.-509/ PP-504 Physiological and Molecular Responses of Plant to Abiotic Stresses 2+1 Sem. II**

**Unit I** Principles of environmental physiology, Response of plants to abiotic stresses and its effect on productivity, Interactions between biotic and abiotic stresses.

**Unit II** Plant responses to freezing, chilling and high temperature, adaptive mechanism, cellular tolerance, protein stability, chaperones, HSPs and role of membrane lipids.

**Unit III** Drought, flooding and anaerobiosis – characteristic features, water potential in the soil-plant-air continuum, Physiological and biochemical processes affected by stress, Oxidative stress-generation of ROS, osmoprotectants, ROS scavenging- enzymatic and non-enzymatic, Water use efficiency (WUE) as drought resistant trait.

**Unit IV** Soil salinity, species variation to salt tolerance, glycophytes and halophytes, salt tolerance mechanism – exclusion, extrusion and compartmentalization, signaling during salt stress- SOS pathway.

**Unit V** High light and high ionizing radiation- photo-oxidation and photo-inhibition, mechanism of tolerance, plant adaptation to low light, shade avoidance response, Air pollutants, green house effects at cellular and whole plant levels.

**Unit VI** Heavy metal toxicity in plants (Al and Cd), tolerance mechanism and approaches to improve the tolerance.

**Unit VII** Hormones signaling in stress, physiological and molecular mechanisms to combat stresses by plants; ABA as signaling molecule; cytokinin as a negative signal, role of ethylene in water logging.

**Unit VIII** Stress perception and signal transduction leading to expression of regulatory genes, mineral cycling and energy transfer in biotic and abiotic components; mutualism, competition, allelopathy; cropland ecosystem.

**Practical :** Measurement of soil and plant water status. Determination of water use efficiency as a drought resistant trait. Experiments to study the effect of freezing, chilling, high temperature, salinity and heavy metal stress on seed germination and seedling growth. Effect of stress on membrane integrity. Experiments pertaining to greenhouse effects and air pollutants. Effects of flooding and anaerbiosis on

seed germination and seedling growth. Effects of water pollutants, heavy metal toxicity and allelopathy in relation to plant growth. Quantification of osmolytes- proline and soluble sugars under stress. Quantification of ROS under stress. Estimation of antioxidant enzymes under stress. Determination of Salinity Tolerance Index. Estimation of free fatty acids in relation to abiotic stress. Estimation of nitrates in irrigation water. Allelopathy and composition of allelochemicals in agri-ecosystems.

**Bot.-510/PP-505 - Growth Regulators** **2+1** **Sem. II**

**Unit I** Definition and classification of growth regulating substances: Classical hormones and Endogenous growth substances other than hormones, Synthetic chemicals.

**Unit II** Discovery, biosynthetic pathways and metabolism of auxin, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids and nitric oxide.

**Unit III** Physiological functions of Auxin, Gibberellins, Cytokinins, Abscisic acid, Ethylene, Salicylic acid, Brassinosteroids and Nitric oxide and use of mutants and transgenic plants in elucidating the physiological functions, Discovery, biosynthetic pathways metabolism and physiological roles of and Peptide hormones.

**Unit IV** Discovery, biosynthetic pathways metabolism and physiological role of Polyamines, Jasmonates, systemins, Concept of death hormone, Growth retardants.

**Unit V** Hormone signal perception, transduction - Receptors, components and mechanism (Auxin, Gibberellin, Cytokinin, ABA and Salicylic acid), Hormone signal perception, transduction - Receptors, components and mechanism (Ethylene, Jasmonate, Brassinosteroids), Advances in elucidating the structure and function of receptors and signaling components of important hormones.

**Unit VI** Genomics approaches to regulate hormone metabolism and its effect on plant growth and development – case studies.

**Unit VII** Crosstalk of Hormones in Regulation of Plant Growth and DevelopmentProcesses.

**Unit VIII** Practical Utility of Growth Regulators in Agriculture and Horticulture.

**Practical :** Bioassay of auxin- effect on rooting of cuttings. ABA bioassays- effect on stomatal movement. Ethylene bioassays, estimation using physico-chemical techniques- effect on breaking dormancy in sunflower and groudnut. GA bioassays- effect on germination of dormant seeds. Cytokinin bioassays- effect on apical dominance and senescence/stay green.

**Bot.- 511/ PP-502 Principles of Plant Physiology-II: Metabolic Processes and Growth Regulation** **2+1** **Sem. II**

**Unit I** Chloroplast ultrastructure with special mention of lamellar system, Excitation,electron and proton transfers and the irrelevance in energy conservation, Concepts of pigment systems and generation of powerful reductant andoxidant, Water oxidation, Water-water cycle and other aspects of electrontransfer.

**Unit II** $CO_2$ diffusion mechanisms and diffusive conductances, concept of Ci determining Photosynthesis, RuBisCO enzyme kinetics and Calvin cycle mechanisms, Regulation of Calvin cycle and metabolite fluxes, Photorespiration: the advantages and inefficiencies of photosynthesis because of photorespiration, Concepts of $CO_2$ concentrating mechanisms (CCM) and spatial and temporal differences in carboxylation, Ecological aspects of $C_2$ and CAM photosynthesis, Product synthesis, Starch and Sucrose biosynthesis.

**Unit III** Mitochondrial organization and functions, Aspects of Glycolysis, TCA cycle and mit ETC., Relevance of growth and maintenance of respiration, Concepts of CN resistance respiration – Alternate and SHAM sensitive ETC.

**Unit IV** Phloem loading and sugar transporting, concepts of bi-directional transport of sugars and other metabolites, Source-Sink relationship and modulation of photosynthesis, Concepts and definitions of Growth and Differentiation, Growth and yield parameters, NAR, CGR, HI and concepts of LAI, LAD.

**Unit V** Developments in d-nitrgen fixation, Nitrate reduction and assimilation GS-GOGAT process for amino acid synthesis, Inter-Dependence of carbon assimilation and nitrogen metabolisms.

**Unit VI** Storage, protective and structural lipids, Biosynthesis of fatty-acids,diacyl and triacyl glycerol,fatty acids of storage lipids, Secondary metabolites and their significance in plant defense mechanisms.

**Unit VII** Growth promoting and retarding hormones: biosynthesis, transport,conjugation, Mode of action of these hormones and their application in plant physiology.

**Unit VIII** Different synthetic hormones: Salicylic acid, strigolactonesetc, Roles and biological activities of various synthetic hormones, Commercial application of hormones to maximize growth and productivity.

**Unit IX** Photoperiodism: Phytochromes, their structure and function, Circadian rhythms, Blue light receptors: Cryptochrome and morphogenesis, Vernalization and its relevance ingermination.

**Practical :** Radiant energy measurements. Separation and quantification of chlorophylls. Separation and quantification of carotenoids. $O_2$ evolution during photosynthesis. Anatomical identification of $C_3$ and $C_4$ plants. Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration. Measurement of respiration rates. Estimation of reducing sugars,starch. Estimation of $NO_3$, free amino acids in the xylem exudates, quantification of soluble proteins. Bioassays for different growth hormones-Auxins, Gibberellins, Cytokinins, ABA and ethylene. Demonstration of photoperiodic response of plants in terms of flowering.

**Bot-591 Seminar** **1+0**

**Bot-599 Master's research** **0+30**

## Ph.D. courses

**Bot.-601 Advances in Botany** **3+0** **Sem. II**

**Unit I** New perspectives of plant development, Molecular and hormonal coordination of plant development, Recent development in control of phyllotaxic patterns of plants, Programmed cell death, Secretary tissues in plants, Applications of plant anatomy in structure -function correlations.

**Unit II** Impact of environmental pollution on plant structure, Plant defense mechanism for disease resistance, Epicuticular waxes and their role in stress tolerance, Phytoremediation of toxic metals.

**Unit III** Root nodule development, Nitrogen fixation by legumes in tropical and sub- tropical crops Biofertilizers, Molecular mechanisms of root nodule development, Long-distance signaling to control root nodule number and role of flavonoids in nodule development.

**Unit IV** Recent development in plant tropism : movement of sessile organisms, Membrane traffic within the golgi apparatus and intra-golgi cargo transport, COPI vesicles as long distance carriers.

**Unit V** Biosynthesis, Histochemistry: sites of biosynthesis, Role of alkaloids in plants.

**Unit VI** Crop simulation models in agriculture, Mechanism of carnivorous nutrition and its application in higher plants, Retrograde signaling in plants: from plastid to nucleus, Application of nanotechnology in agriculture.

**Unit VII** Weed biology, Ecology and physiology of weeds, Weed and crop competition, Allelochemicals: nature and impact, Weed- seed physiology.

**Bot.-602 Advances in Plant Physiology** **2+1** **Sem. II**

**Unit I** Scope of plant physiology in the era of second green revolution, Conventional and biotechnological approaches to improve yield potential and quality of crop plants, New emerging technologies and their scope in crop improvement, ABC- transporters.

**Unit II** Signal, signal types, long (diffusible) and short (contact) range signaling and components of signaling, Types of receptors: Cell surface trans-membrane receptors- GPCRs, Receptor Tyrosine Kinases (RTKs), Receptors Serine Threonine Kinases (RSTKs), Receptor-Like Kinases (RLKs), receptor two component systems, Nature of ligands, downstream components like primary, secondary signaling components G-proteins, second messengers-Cyclic AMP, Adenylate cyclase cascade, cyclic GMP, calcium-calmodulin-kinases; effector molecules (transcription factor), Signal transfer phosphor-relay and generation of secondary signaling components and activation of TFs or enzymes.

**Unit III** Hormone binding receptors-Transduction process. Effector molecules and gene expression, Specific signaling pathways of Auxins, Cytokinin, Gibberellins, Ethylene, ABA, Brassinosteroids, Salicylic Acid, Strigolactone, polyamines, Jasmonic acid, etc. which leads to formative effects, Cross talk in the signaling of different hormones-significance of studies with hormone action mutants, Elements of signaling pathways and mechanism of signal transduction; two components sensing system.

**Unit IV** Calcium sensors, Signals and cytoplasmic calcium.

**Unit V** Sensing of environmental factors (Temperature-Osmotic-Ionic stress), Activation of specific molecules and secondary messengers, activation of downstream components-leading to stress gene expression, Case studies with different abiotic stresses, Retrograde signaling, Nitrogen fixation, nitrogen and phosphorus uptake, nutrient translocation, Molecular aspects of nutrient uptake and transport, nutrient sensing and signaling.

**Practical :** Assessment of quality attributes in various crops: Physical appearance, 100 seed weight, hectolitre weight. Free fatty acids and total oil content in *Brassica* seed. Total protein, total starch, gluten content in wheat grains. Estimation of phytohormones through chromatographic techniques (HPLC, GCMS). Effect of abiotic stresses on seed germination, seedling vigour index, shoot root ratio, relative water content, yield attributes in field crops. Determination of osmolytes in various plant plants under abiotic stress. Quantification of enzymes involved in various metabolic processes under stresses. Measurement of leghaemoglobin content in nodules. Estimation of various macro-elements.

**Bot.-603 Advances in Reproductive Biology** **2+0** **Sem. I**

**Unit I** Introduction: Approaches to study mechanisms of reproductive development.

**Unit II** Cell determination and interactions in reproductive organ development, Floral induction, Physiological signals and multi-factorial system of control of floral metamorphosis, ABC model for floral organ specifications, Development of egg cell and its role in fertilization, Suspensor and its importance in embryo development, Endosperm origin, development and functions, Molecular basis of microsporogenesis.

**Unit III** Fruit growth and development, Fruit ripening, Role of fruit wall in seed development, Physiological and molecular aspects of fruit ripening and senescence, Role of plant hormones in reproductive development, Seed development, deposition of storage reserves, Mechanisms of seed and fruit abortion and means to overcome, Embryo maturation and desiccation, Cytoplasmic male sterility and hybrid seed production.

**Unit IV** Self and cross pollination: mechanisms influencing mode of pollination, Pollen-pistil interactions, Self-incompatibility mechanisms, Regulation of pollen viability, germination and tube growth, Mutations affecting gametophyte development, Impact of environmental factors on reproductive development in relation to productivity, Genetic modification for extending post harvest life of flowers and fruits.

**Bot.-604 Advances in Morphogenesis** **2+0** **Sem. I**

**Unit I** Cell cycle regulation, Cytokinesis in pattern formation: asymmetric cell division in plants, Meristems in plant development, Plasma membrane interaction with the cytoskeleton and cell wall.

**Unit II** Initiation of developmental pathways, Hormonal regulation of developmental processes, Apical dominance: Theories and hormonal regulation significance, Abnormal plant growth: Hormonal and elemental control.

**Unit III** Photoreceptors : Various types, Phytochrome and control of plant development, Blue-light mediated responses and morphogenesis, Photoregulated gene expression in plants, Phytochrome transgenes and their biotechnological applications.

**Unit IV** Plasmodesmata: Dynamics, domains , patterning and intracelluar communication, Trichome development: Morphogenesis, molecular and genetic analysis, Stomatal development: Orientation and patterning of stomatal development, Genetic architecture and model for leaf morphogenesis.

**Bot.-605 Molecular Approaches for Improving Physiological Traits in Crop Plants 3+0 Sem.I**

**Unit I** Introduction, Nutrient acquisition, Abiotic and biotic stress tolerance.

**Unit II** Importance of mutants in unraveling important physiological processes, Importance of molecular plant breeding in crop improvement,Basic aspects of genomics, proteomics, and metabiomics and their potential application.

**Unit III** PCR rationale, techniques and applications, DNA- based marker systems and their applications, Linkage maps and mapping populations, Strategies for quantitative traits loci (QTL) introgression and marker assisted selection (MAS) for crop improvement.

**Unit IV** Gene transfer methods, Selection of transformants and their analysis using physiological / biochemical and molecular approaches, Applications of transgenics, Molecular farming, Issue related to biosafety and registration of genetically modified (GM) crops.

**Bot.-606/ PP-606 Global Climate Change and Crop Response 2+0 Sem. II**

**Unit I** Greenhouse gases and their influence on climate change and ecosystems, Long and short-term projections of climate change: natural vegetations area shift, food production, Crop-pest interaction.

**Unit II** Temperature stress: Classification inf response to stress Response: Morphological, Physiological, Biochemical, molecular signaling during stress tolerance Avoidance, tolerance, acclimation mechanism.

Water stress: Classification inf response to stress Response: Morphological, Physiological, Biochemical, molecular signaling during stress tolerance Avoidance, tolerance, acclimation mechanism.

Salt stress: Classification inf response to stress Response: Morphological, Physiological, Biochemical, molecular signaling during stress tolerance Avoidance, tolerance, acclimation.

Light stress: Classification inf response to stress Response: Morphological, Physiological, Biochemical, molecular signaling during stress tolerance Avoidance, tolerance, acclimation.

Heavy metal stress : Classification inf response to stress Response: Morphological, Physiological, Biochemical, molecular signaling during stress tolerance Avoidance, tolerance, acclimation.

**Unit III** Direct and indirect effects of environmental stresses on plant processes, Phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield.

**Unit IV** Relevance of “Genome wide mutants” to identify genes/processes for improved adaptation to changing environments, International conventions and global initiatives on carbon sequestration, carbon trading.

**Bot.-607 Seed Physiology 2+0 Sem. I**

**Unit I** Importance and structure of seeds, Physiology of seed and fruit development, Environmental effects on seed development, Physiological and molecular aspects, Seed development patterns and source of assimilates.

**Unit II** Chemical composition, biosynthesis, storage of carbohydrates, proteins and fats in seeds, Mobilization of assimilates in developing seeds, Chemistry of oxidation of starch, protein and fats, Utilization of breakdown products by embryonic axis.

**Unit III** Inception of germination, Hormonal and molecular regulation of seed germination events. Seed respiration, Seed ageing, Seed maturation and desiccation damage, Role of LEA proteins; precocious seed germination.

**Unit IV** Seed viability: physiological and genetic aspects to prolong viability, Seed vigour: concept, importance, measurement; invigoration - methods and physiological basis: orthodox and recalcitrant seeds, Types of seed dormancy, Structural and chemical basis of seed coat impermeability and hard seededness; means to overcome dormancy, Gene imprints and seed and fruit abortion and means to overcome it.

**Bot.-608/ PP-608 Seed and Fruit Growth and Their Quality Improvement 2+0 Sem. I**

**Unit I** Mechanism of seed development and different developmental stages; synthesis, mobilization and accumulation of stored reserves, Forms of stored reserves and their localization, Sink drawing ability (SDA) and its relevance in seed growth and development, Role of plant hormones in seed growth and development and SDA.

**Unit II** Seed as a propagation material; seed size and seed chemical composition and their relevance in seed germination, Physiological, biochemical and molecular mechanisms and approaches to regulate seed germination, seedling emergence and establishment and seedling vigour, Physiological, biochemical and molecular mechanisms and approaches to regulate seed priming and crop establishment: seed dormancy, precocious germination and controlling pre-harvest sprouting in crops, Physiological, biochemical and molecular mechanisms and approaches to regulate seed viability, improving the viability and storability of seeds.

**Unit III** Seed as a source of nutrition to humans: approaches to improve the quality of seeds through synthesis of seed storage reserves and other constituents, Genes/QTL's regulating these processes and concept of pathway engineering to improve the quantity and quality of seed constituents, Carbohydrates-Amylose and amylopectin ratios for glycemic index, resistant and digestable starch, improving dietary fibre, alter gelatinisation, Protein content, modified proteins, essential amino acids, Oil content, fatty acid composition, Omega 3 fatty acids. Carotenoids and vitamins, Biofortification strategies to enhance the grain zinc, iron, other minerals and other essential compounds, Engineering for low protease inhibitors, phytic acid, tannins, phenolic substances, lectins, oxalates as anti-nutritional factors, Case studies of improving seed nutrition components by molecular breeding and transgenic approaches.

**Unit IV** Changes in chemical composition during storage; factors influencing the deterioration of nutritional quality of seeds during storage; approaches to minimize nutritional quality deterioration, Effect of quality deterioration on human and animal health.

**Unit V** Flower and fruit development; concept of parthenocarpy, Physiological and biochemical changes during fruit development and chemical composition, Molecular approaches to regulate flower and fruit drop/ abscission; Role of hormones.

**Unit VI** Biosynthetic pathways and the quantification and options to improve by hormonal and molecular pathway engineering approaches of Antioxidants, Flavanoids, anthocyanins, Biosynthetic pathways and the quantification and options to improve by hormonal and molecular pathway engineering approaches of Vitamins- Vitamin C, Tocopherol, Carotenoids, Biosynthetic pathways and the quantification and options to improve by hormonal and molecular pathway engineering approaches of Alkaloids, Mangiferin, tomatins, Biosynthetic pathways and the quantification and options to improve by hormonal and molecular pathway engineering approaches of DigestableFiber lycopene, stillbeans, Biosynthetic pathways and the quantification and options to improve by hormonal and molecular pathway engineering approaches of Aroma, monoterpenoids and Fatty acid esters.

**Unit VII** Physiological and molecular mechanisms of fruit ripening, Postharvest deterioration of fruits; factors regulating fruit deterioration; hormonal and environmental aspects of reducing post harvest deterioration of fruits, Physiological and Molecular approaches to regulate fruit ripening and shelf life: Role of Ethylene and Ethylene response factors regulating specific processes of fruit ripening; Approaches to regulate specific shelf life characters, Improving fruit ripening and shelf life by molecular approaches-Case studies.

**Bot.-609/ PP-602 Signal Perceptions and Transduction and Regulation of Physiological Processes 2+0 Sem. II**

**Unit I** Signal, signal types, long (diffusible) and short (contact) range signaling and components of signaling, Types of receptors, nature of ligands, downstream components like primary, secondary signaling components.

**Unit II** Cell surface trans-membrane receptors- GPCRs, Receptor Tyrosine Kinases (RTKs), Receptors Serine Threonine kinases (RSTKs), Receptor-Like Kinases (RLKs), receptor two component systems, Signal transfer phosphor-relay and generation of secondary signaling components and activation of TFs

or enzymes, Downstream components- G-proteins, second messengers-Cyclic AMP, Adenylate cyclase cascade, cyclic GMP, calcium-calmodulin-kinases; effector molecules (transcription factor).

**Unit III** Hormone binding receptors-Transduction process. Effector molecules and gene expression, Specific signaling pathways of Auxins, Cytokinin, Gibberellins, Ethylene, ABA, Brassinosteroids, Salicylic Acid, Strigolactone, polyamines, Jasmonic acid, etc. which leads to formative effects, Cross talk in the signaling of different hormones-significance of studies with hormone action mutants.

**Unit IV** Perception of light-pigments involved- activation of phytochrome/cryptochrome (study of mutants), Light signal transduction, Multiple signaling cascades-identification of signaling components through mutant analysis-changes in gene expression.

**Unit V** Sensing of environmental factors (Temperature-Osmotic-Ionic stress), Activation of specific molecules and secondary messengers, activation of downstream components-leading to stress gene expression, Case studies with different abiotic stresses, Retrograde signaling, Nitrogen fixation, nitrogen and phosphorus uptake, nutrient translocation.

**Unit VI** Leaf senescence/fruit development and ripening, Tuberization, Sugar signaling, Signaling during seed germination.

**Unit VII** General mechanisms to pathogen response, Role of salicylic acid and active oxygen species, Cross Talk Signaling- Stress matrix under field conditions, cross talk between abiotic- abiotic stress, biotic-abiotic stress signaling networks.

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| **Bot-691 Seminar I** | **1+0** |
| **Bot-692 Seminar II** | **1+0** |
| **Bot-699 Ph.D Research** | **0+75** |

# BUSINESS STUDIES

## PROGRAMMES

**MBA**
**Ph.D. (Business Administration)**
**MBA (Agribusiness)**

## COURSE REQUIREMENT

### MBA

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|---|---|
| Field of Specialization | Marketing Management, Financial Management, Production Management, Human Resource Management Agribusiness Management, e-business. |
| Required Courses | Mgt.-501, Mgt.-502, Mgt.-503, Mgt.-504, Mgt.-505, Mgt.-506, Mgt.-507, Mgt.-508, Mgt.-509, Mgt.-536, Mgt.-537, Mgt.-538, Mgt.-539, Mgt.-540, Mgt.-541, Mgt.-542, Mgt.-543, Mgt.-544 |
| Supporting Courses | Stat.-502, Stat.-512 |
| Minor Fields | Business Management |
| Deficiency Courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |

### Ph.D.

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|---|---|
| Field of Specialization | Financial Management, Marketing Management, Human Resource Management |
| Required Courses | Mgt.-601, Mgt.-602, Mgt.-603, Mgt.-604, Mgt.-608, Mgt.-610 |
| Supporting Courses | Stat.-522, Stat.-526 |
| Minor Fields | Business Management |
| Deficiency Courses | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### MBA (Agribusiness)

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|---|---|
| Field of Specialization | Agribusiness |
| Required Courses | ABM-501, ABM-502, ABM-503, ABM-504, ABM-505, ABM-506, ABM-507, ABM-508, ABM-509, ABM-536, ABM-537, ABM-538, ABM-539, ABM-540, ABM-541, ABM-542, ABM-543, ABM-544. |
| Supporting Courses | Stat.-502, Stat.-512 |
| Minor Fields | Agribusiness Management |
| Deficiency Courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504 and PGS-505 |

# Description of Course Contents

## Undergraduate Courses

**Mgt. 51 Introduction to Marketing Management** **2+0** **Sem. I**

Introduction to marketing management. Marketing concepts and managerial functions of marketing. Understanding market and marketing management, segmentation targeting and positioning. Marketing mix-product, price, place and promotion. Developing marketing strategies for services. Marketing practices of selected Indian companies.

**Mgt. 52 Production and Personnel Management** **2+0** **Sem. II**

Production management-introduction, objectives and role. Production control for continuous, intermittent and project systems. Plant location and layout. Production scheduling and control. Personnel management-introduction, nature, objectives, role and scope. Functions of personnel management manpower planning, recruitment, selection, training and development, performance appraisal, motivation and morale.

**Mgt. 53 Accounting and Financial Management** **2+0** **Sem. II**

Financial accounting - meaning and principles. Accounting records and systems-journal, ledger, cash book and trial balance. Preparation of profit and loss account and balance sheet. Management accounting - meaning and scope. Marginal costing and cost volume, profit analysis. Budgeting and budgetary control systems. Financial management-meaning, objective and scope. Finance functions and forms of organization. Assessment of financial requirements for an enterprise. Sources of finance. Capital structure and cost of capital. Capital budgeting.

**Mgt. 54 Entrepreneurial Development** **2+0** **Sem. II**

Introduction to the concept of entrepreneurship, classification and types of entrepreneurs, women entrepreneurs, institution in aid of entrepreneurs. Steps for starting a small industry, site selection, selection of type of organization. Brief introduction to various functional area of enterprise management viz. finance and accounts, marketing production/operation, personnel, MIS and R&D. Problems of entrepreneurs specially problems faced by women entrepreneurs, key success factors in small scale industry.

**Mgt. 101 Principles of Management and Organizational Behavior** **3+0** **Sem. I**

Introduction to Management-Management functions -Management levels- Managerial Roles-Management skills-Role of management. Evolution of management thought. Functions of management: Planning: Nature and importance- types of planning - Steps in planning -Decision making-meaning-types of decisions. Organizing- meaning-nature and purpose of organizing-Principles of organizing- Organization structure -Managing Human Resources- human resource planning recruitment- sources of recruitment -Selection-steps in the selection process- Orientation -Training -Management development programme. Leading-meaning -Leadership theories -Motivation-Meaning and purpose- Motivational Theories-Communication-meaning-objectives-importance-types barriers. Controlling-meaning and nature of controlling-essential elements of controlling. Ethics and corporate social responsibility in business. Organizational Behavior-definition, importance, historical background of Organizational Behavior, challenges- the organizational context-Environment Technology- Learning- importance of learning-Process-approaches to learning-the learning organization. Personality-defining personality-types and traits-personality types-the big five-the development of the self-selection methods- Perception- meaning, selectivity and organization-perceptual sets and perceptual worlds- factors influencing perception and shortcuts in judging others group Dynamics - meaning, need for joining groups, stages of group development and group decision making techniques. Teams-types, difference between teams and groups. Managing conflicts. Work stress - Types and management strategies. Organizational culture — Definition and creating a culture in organization. Organizational change Preparation, analysis and presentation of case studies.

**Mgt. 102 Introduction to Financial Accounting** **2+1 Sem. I**

Introduction to Accountancy: Meaning and importance of accounting. Meaning and definition of book keeping. Accountancy objectives of Book Keeping, Branches of accounting. Accounting Cycle. Generally Accepted Accounting Principles (GAAP) – concepts and conventions. System of Book Keeping: Single Entry and Double entry system of book keeping, Classification of accounts. Golden rules of accounting, Books of accounts: Journal & Ledger – Journalising, ledger posting, and preparation of ledger accounts, Subsidiary Books- Kinds of subsidiary books- Day books: Purchase Book, Sales Book, Returns Book, Bill Books, Journal proper, Cash Books- Nature & Objectives of cash book, types of cash book, petty cash book; Bank reconciliation statement; Concepts of Revenue and Capital Expenditure and income, Receipts and Payment account, preparation of trial balance- methods of trial balance: final accounts-Trading accounts, profit and loss accounts and Balance Sheet.

**Practical** : Preparation journal and recording the business transaction in Journal, preparation of ledger and ledger posting, preparation and solving of problems relating to subsidiary books, preparation of cash book with single column, preparation of case book of double column, preparation of cash book with triple column and contra entries, preparation of petty cash book in impress system, preparation of bank reconciliation statement preparation of trial balance, preparation of final account-Trading, profit and loss account and balance sheet.

**Mgt. 103 Business Environment and Ethics** **2+0 Sem. II**

Scope importance and types of Business Environment. Environmental factors and scanning. Globalization, privatization and WTO. Contracts meaning, significance, types and essentials of a valid contract. The Indian Contract Act-1872. The Companies Act, 1956 and 2013 - General Nature, types of companies, incorporation of a Company, Memorandum of Association and Articles of Association, management of a company. Provisions of important Acts enacted over time related to business environment. Foreign Exchange Regulation Act (FERA), 1973; Foreign Exchange Management Act (FEMA). Competition Act, 2002, Food safety and standards Act, 2006. Business Ethics - Nature and importance of ethics and moral standards. Scope of business ethics in business functional area. Corporate social responsibility.

**Mgt. 104 Financial Management** **2+1 Sem. II**

Introduction to financial management. Objective of financial management. The time value of money. Process of compounding and discounting. Capital Budgeting: Long term investment decisions. Nature of investment decisions. Forms of investment decisions. Capital budgeting process - Estimation of project cash flows, Evaluation of proposals. Evaluation techniques- Discounting and non-discounting techniques. Sources of Long-Term finance. Cost of Capital. Capital structure: importance, factors influencing capital structure and features of an optimal capital structure. Leverage: leverage in financial context, measures of leverage. Estimation of Working Capital Requirements: Concept, factors affecting the working capital requirement - operating cycle approach. Criteria for evaluation of working capital management. Receivables Management: purpose and cost of maintaining receivables. Credit policy.

**Practical** : Appraisal of project proposals using capital budgeting techniques. Computation of costs of borrowed capital, preferred stock, equity capital and retained earnings. Calculation of Operating Leverage, Financial Leverage and Combined Leverage. Estimation of operating cycle.

**Mgt. 105 Entrepreneurship Development in Agribusiness** **1+1 Sem. II**

Entrepreneur and entrepreneurship: Meaning, definitions, Phases or steps of setting up of agribusiness start-up. Sources of funding of start-up. Business plan and its components. Entrepreneurship development: Definitions, need, scope and motive factors SWOT analysis. Achievement motivation. Entrepreneurial behaviour Government policy for entrepreneurship development Government programmes for promotion of entrepreneurship Entrepreneurial development process/programme: objective, phases, and problems Developing organizational skills and managerial skills. Problem solving skills. Project planning formulation and report preparation. Opportunities for Entrepreneurship and rural Entrepreneurship. Procedure for setting up of a small-scale industry.

**Practical** : Assessing entrepreneurial potential /traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, monitoring and supervision, identification and selection of

business idea, preparation of business. Plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

**Mgt. 201 Entrepreneurship Development and Business Management 2+1 Sem I/II**

Entrepreneurship - introduction, definition, concept and importance. Factors affecting entrepreneurship. Entrepreneur – characteristics, types and functions. Steps for starting a small enterprise. Environmental scanning and opportunity identification. SWOT Analysis. Venture capital, joint ventures and public private partnerships. Government policies, programs and institutions supporting small entrepreneurs. Problems of small entrepreneurs. Management - definition, importance and functions. Planning - definition, steps, types and characteristics. Organizing - meaning, formal and informal organization. Directing – introduction to motivation, leadership and communication. Controlling - meaning, process and need. Introduction to financial management. Introduction to balance sheet and profit and loss statement. Ratio Analysis – liquidity, leverage, coverage, turnover and profitability ratios. Sources of short- and long-term funds. Introduction to project management. Project planning, formulation and report preparation. Introduction to production management. Introduction to marketing management. Introduction to international trade and WTO agreements - Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS). Business - value chain concept and stakeholders. Importance of agribusiness in Indian economy and factors transforming Indian agribusiness. Government as a regulatory body in agribusiness. Opportunities and challenges to Indian agribusiness.

**Practical** : Case studies of successful entrepreneurs, analysis and discussion – assessing entrepreneurial traits, problem solving skills, managerial skills, achievement motivation and creativity. Visits to subject specific enterprises and agri-business houses and interaction with successful entrepreneurs. Formulation of project and report writing for starting a new venture – idea generation, market and demand feasibility, technical and financial feasibility and project appraisal techniques. Preparation of complete marketing plan of selected product /service.

**Mgt. 202 Marketing Management and International Trade 2+0 Sem. I**

Marketing Management - concept, functions and scope. Marketing mix - concept and elements. Market structure, environment and consumer buying behavior. Marketing research and marketing information systems. Market measurement and forecasting. Market segmentation, targeting and positioning. Marketing planning process. Product - policy, planning and life cycle. Product-mix, product line and new product development process. Branding, packaging and service decisions. Marketing channel decisions. Retailing, wholesaling and distribution. Pricing decisions - determination and pricing policy of milk products in organized and unorganized sectors of dairy industry. Promotion-mix decisions. Advertising - objectives, budget and message, media planning, personal selling, publicity and sales promotion. World consumption of food – patterns and type of food consumption across the globe. Salient features of international marketing, composition and direction of Indian exports, international marketing environment, and international market entry decision. Direct exports, indirect exports, licensing, joint ventures, direct investment and internationalization process, international distribution channels. WTO and world trade agreements related to food business, export trends and prospects of food products in India; Government institutions related to international food trade - APEDA, Tea Board, Spice Board, MOFPI, etc.

**Mgt. 204 Business Management and Economics 2+0 Sem. II**

Management - definition and principles. Management functions - planning, organizing, staffing, directing – motivation concept and Maslow's hierarchy of needs theory and controlling. Organization - structure and principles. Types of organization - formal and informal, line and staff, matrix and hybrid. Introduction to economics - definition, nature, scope, difference between microeconomics and macroeconomics. Theory of demand and supply, elasticity of demand, price and income elasticity. Markets - types and their characteristics. National income - GDP, GNP, NNP, disposable personal income, per capita income and inflation. Theory of production - production function and factors of production. Law of variable proportions and law of returns to scale. Cost - short run and long run, fixed, variable, total, average, marginal and opportunity cost. Break even analysis. Financial management - definition, scope and objectives. Different

systems of accounting – financial, management and cost accounting. Human resource management - definition, objectives of manpower planning, process, sources of recruitment, process of selection. Corporate social responsibility – importance and business ethics.

**Mgt. 205 Marketing Management** **2+0 Sem. I**

Marketing meaning, importance, functions. Marketing Management- definition, Difference between marketing and selling. Marketing planning: importance, steps, nature. Market Segmentation - meaning, bases and advantages; Market Targeting - Approaches. Positioning - meaning and strategies. Marketing environment analysis. Marketing Mix - 4 Ps and 7 Ps; Product. Product classifications and new product development and launching. Product life cycle - stages; Branding - meaning, selecting a brand, advantages and disadvantages of branding, Packaging: meaning, importance, and functions of packaging. Pricing Methods and strategies. Marketing channel - meaning, market intermediaries, types of channels and functions of marketing channel; channel management strategies, channels of distribution, channel management decisions, management of retailing and wholesaling. Direct marketing - methods and advantages and disadvantages; Promotional mix: meaning, elements and objectives. Services Marketing -introduction, meaning, characteristics.

**Mgt. 301 Fundamentals of Entrepreneurship** **2+0 Sem. II**

Basic concepts of entrepreneurship: need and scope of entrepreneurship, forms of organization. Steps for starting a small business, various functional areas of business management. Finance: sources of funds. Production management: production system, site selection. Marketing: various marketing concepts, marketing mix, distribution and retail management. Introduction to other functional areas: HRM, MIS, R&D. Institutions supporting small entrepreneurs. Problems of small entrepreneurs, key success factors for small business.

**Mgt. 302 Accounting and Inventory Management** **2+0 Sem. I**

Financial accounting: accounting principles. Accounting cycle- journal, ledger, trial balance. Preparation of financial statements, understanding published financial statements. Cost accounting: basic concepts, classification of costs, preparation of cost sheet, cost- volume- profit analysis and its applications, use of accounting software. Inventory management: definition, costs, risks, inventory management techniques, Economic order quantity, re-order level, safety stock, ABC analysis, VED analysis, FSN analysis, ageing schedule etc.

**Mgt. 303 Fundamentals of Agri-business Management and Entrepreneurship Development** **2+0 Sem. II**

Agri-business- meaning, definition, features and structure of agri-business (input, farm and processing sectors). Importance of agri-business in the Indian economy. Management- definitions, importance and functions. Planning- meaning, definition and process. Types of plans and characteristics of a sound plan. Introduction to organising, staffing, directing and controlling. Introduction to marketing management components of marketing mix. Project definitions. Project cycle- identification, formulation, appraisal, implementation, monitoring and evaluation. Entrepreneurship development- concept of entrepreneurship, entrepreneurial and managerial characteristics. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Procedure and constraints in setting up agro-based industries.

**Mgt. 304 Agribusiness Management** **2+1 Sem. II**

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy. Distinctive features of Agribusiness Management. Agro based Industries - importance, needs, types and constraints. Institutional arrangement, procedures to set up agro based industries. Agri-value chain - understanding primary and support activities and their linkages. Business Environment: PEST &SWOT Analysis. Introduction to Management functions: Planning - definition, steps and implementation. Types of plans - purpose or mission, goals or objectives, strategies, policies, procedures, rules, programs and budget. Components of a business plan. Organization staffing, directing, leading and motivation, communications and control. Capital management and financial management of Agribusiness. Financial statement and

their importance. Marketing management - segmentation, targeting & positioning. Marketing mix and strategies. Consumer behavior analysis, Product Life Cycle (PLC). Sales & distribution Management. Pricing policy and methods. Project Management - definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation.

**Practical** : Study of agri-input markets - seed, fertilizers, pesticides. Output markets - grains, fruits, vegetables, flowers. Product markets, retail trade, commodity trading, and value-added products. Financing institutions - cooperative, commercial banks, RRBs, NABARD. Preparations of projects and feasibility reports for agribusiness entrepreneur. Project appraisal/evaluation techniques. Case study of agro-based industries.

**Mgt. 305 Managerial Accounting** **2+1** **Sem. I**

Definition, Meaning, Nature, Objectives, Scope, Importance, Advantages and Limitations of Management Accounting, Distinction Among Financial, Cost And Management Accounting Systems. Financial Statement Analysis-Meaning, Nature, Uses and Limitations Of Financial Statements Financial Analysis Tools Comparative Financial Statements, Common Size Financial Statements, Trend Analysis, Ratio analysis -meaning & expression of ratios, objectives and importance of Ratio analysis. Classification and computation of liquidity ratios, solvency ratios, activity ratios and profitability ratios. Cash flow statement - concepts, objectives, uses and preparation of cash flow statement, source and applications of cash, cash from operation, procedure of cash flow statement, difference between funds and cash flow statement. Cost Management-Definition and Purpose of Cost Accounting. Business Environment: Just-in-Time (JIT), Total Quality Management (TQM), Process Reengineering, The Theory of Constraints (TOC); Concept of Cost, Cost Centre, Cost Unit, Elements of Cost, Classification of Cost, Analysis of Total Cost, Cost Sheet. Volume Profit analysis Break-even chart, Profit Graph Activity based costing, Budgetary control, Nature and Scope, Organization for Budgetary Control, Preparation of Various Functional and Master Budgets, Fixed Vs. Flexible Budgeting Standard Costing- Nature and Scope, Types of Standards; Standard Costing Methods - standard Costing - material, labour and overhead variances -Inflation accounting - Accountant and the role of computers in Accounting.

**Practical :** Preparation of comparative and common size statements, trend analysis, Computation of interpretation of ratios, Analysis of financial statements of Joint Stock Companies and Co-operatives. Preparation of cash flow and funds flow statements, Preparation of Break Even Chart and Profit Graph, Exercises in Activity Based Costing, Preparation of Functional Budgets, Flexible Budgets, Exercises in Variance Analysis and Inflation Accounting.

**Mgt. 306 Strategic Business Management** **2+1** **Sem. II**

Introduction to Strategies: Introduction, Fundamentals of Strategy, Conceptual Evolution of Strategy, Scope and Importance of Strategies. Strategic Management: Introduction, Need, scope, key features and importance of strategic management. Strategists at various management levels, Types of Strategies, Limitations of Strategic Management. Strategy Analysis and its Importance. The External Environment-The General, Industry, and Competitor Environments-External Environmental Analysis-Scanning- Monitoring- Forecasting – Assessing Segments of the General Environment -The Demographic Segment -The Economic Segment-The Political/Legal Segment The Sociocultural Segment The Technological Segment The Global Segment-Industry Environment Analysis-Competitor Analysis Ethical Considerations. The Internal Environment The Nature of Internal Environmental Analysis- The Context of Internal Analysis-Creating Value -The Challenge of Internal Analysis -Resources, Capabilities, and Core Competencies-Building Core Competencies -Value Chain Analysis-Outsourcing-Competencies, Strengths, Weaknesses, and Strategic Decisions. Business Level Strategy-The Purpose of a Business-Level Strategy-Types of Business-Level Strategies-Cost Leadership Strategy- Differentiation Strategy -Focus Strategies-Integrated Cost Leadership/Differentiation Strategy. Competitive Rivalry and Competitive Dynamics-Competitor Analysis –Market Commodity, Resource Similarity Drivers of Competitive Actions and Responses-Strategic and Tactical Actions-Type of Competitive Action. Corporate-Level Strategy -Levels of Diversification -Value-Creating Diversification: Related Constrained and Related Linked Diversification -Unrelated Diversification –Value Neutral Diversification: Incentives and Resources-Value-Reducing Diversification: Managerial Motives to Diversify. Acquisition and Restructuring Strategies-Merger and

Acquisition Strategies-Reasons for Acquisitions-Restructuring-Downsizing- Down scoping. International Strategy -Identifying International Opportunities: Incentives to Use an International Strategy-International Business-Level Strategy-International Corporate-Level Strategy-Environmental Trends-Risks in an International Environment-Political Risks-Economic Risks. Cooperative Strategy-Strategic Alliances as a Primary Type of Cooperative Strategy-Business Level Cooperative Strategy-Corporate-Level Cooperative Strategy-International Cooperative Strategy-Network Cooperative.

**Practical :** Case studies of agribusiness units with respect to their objectives and evaluation of their business strategies, strategic alliances, strategy implementation, implications and challenges.

**Mgt. 421 Introduction to Management and Marketing** **2+0 Sem. II**

Nature and process of management, forms of business organization, nature and process of planning. Organizing - nature, process, authority relationship, delegation of authority, centralization and decentralization, directing, communication, motivation, leadership. Controlling - nature and concept, functional areas of management, marketing management - nature and concept, marketing decisions, marketing strategy, market segmentation and consumer purchase behavior.

**Mgt. 422 Agribusiness Management and Trade** **3+0 Sem. I**

Management concepts: introduction, scope, theories and principles. Introduction to functions of management- planning, organizing, staffing, directing and controlling. Agribusiness- concept, agribusiness system and application of management principles to agribusiness. Production, processing, consumption and marketing of agricultural products. Problems related to processing and marketing of agricultural products in Indian context. International trade- basics, classical theory, theory of absolute advantage, theory of comparative advantage and modern theories. Free trade- protection, methods of protection including tariff and non-tariff barriers. Balance of trade and balance of payments. Introduction to GATT and WTO. World trade agreements related to food business- agreement on agriculture, aggregate measure of support, sanitary and phyto-sanitary and safeguard measures. World consumption of food-pattern and types of food consumption across the globe. Export trends and prospects of processed food in India. Management of export-import organization- registration, documentation and export-import logistics. Government institutions related to international food trade.

**Mgt. 423 Introduction to Entrepreneurship and Marketing** **2+1 Sem. I**

Concept of entrepreneurship, entrepreneurial and managerial characteristics. Managing an enterprise. Importance of planning, monitoring and evaluation and follow-up. Generation, incubation and commercialization of ideas and innovations. Steps for starting a new venture- selection of product/ service and site selection. Sources of funds. Constraints in setting up a new venture. Preparation of project report for starting a new venture, SWOT analysis. Government schemes and incentives for promotion of entrepreneurship. Marketing management- meaning, definition, segmentation, targeting, positioning and 4P's of marketing mix. Product- product life cycle, developing new products. Pricing- meaning, steps for determining price. Introduction to channels of marketing and promotional tools.

**Practical** : Preparation of project report for starting a new venture. Case studies of successful entrepreneurs. Preparation of complete marketing plan of selected product/service including segmentation, targeting, positioning and various components of marketing mix such as product, price, channel and promotion.

**Mgt. 424 Fundamentals of Marketing Management** **2+0 Sem. I**

Marketing management: meaning, significance and importance of markets and marketing. Marketing environment, marketing research, marketing mix. Segmenting, targeting and positioning. Buyer behaviour: motives and factors influencing the various stages of buying process. Product decisions: product life cycle, new product development, product planning, product mix, product line and branding decisions, packaging and labelling. Pricing decisions: methods of pricing, price adaptations. Introduction to marketing channels and promotion mix. Introduction to sales management.

**Mgt. 433 Financial and Project Management** **3+1 Sem. I**

Importance, need, scope and functions of finance. Concept of time value of money. Capital budgeting concept and steps in capital budgeting, appraisal criteria- payback period, average rate of return, net

present value, benefit cost ratio and internal rate of return. Working Capital Management- concept, determinants and need for working capital in agribusiness. Introduction, objectives and techniques of inventory management for agribusiness. Introduction to cost of capital and capital structure. Project management- concept, characteristics and types of projects. Project feasibility- market, technical, financial and economic feasibility. Project risk analysis. Estimating financial requirements of projects and sources of finance.

**Practical** : Case studies related to financial management and project management. Visits to agri-business industrial houses. Numerical problems based on capital budgeting. Preparation of project report for various agri-business ventures.

**Mgt. 434 Retailing and Supply Chain Management 3+0 Sem. I**

Introduction to retailing- definition, concept and overview. Types of retail institutions related to agri-business. Changing food consumption patterns in India. Store location and site selection. Managing retail operations procurement and inventory management. Store design- the exterior, interior, layout and display. Promoting store. Introduction to customer relationship management in retail business. Supply chain management concept, definition and importance. Elements of physical distribution systems, building and operating supply chains in agribusiness. Role of IT in supply chain management.

**Mgt. 491 Agro – Industrial attachment 0+4 Sem. I**

**Agribusiness Industry in Public / Private Sector (for agribusiness Management Practices / Processes)**

## Postgraduate Courses

**Mgt.-501 Principles of Management and Organizational Behaviour 3+0 Sem. I**

**Unit I** Introduction to Management: Nature, Scope and Significance of Management, Evolution of Management Thought, Approaches to Management, functions and skills of a manager.

**Unit II** Management functions: Planning - Types, Steps, Objective, Process, Strategies, Policies, MBO, organizing – Structure & Process, Line, Staff, Authority & Responsibility, Staffing – Recruitment and Selection, Directing – Training, Communication & Motivation, Controlling- Significance, Process, Techniques, Standards & Benchmarks, Management Audit.

**Unit III** Nature, Scope and Significance of Organizational Behavior; Foundations of Individual behaviour – Emotions, Personality, Values, Attitudes, Perception, Learning and individual decision making, Motivation- Types of motivation, theories of motivation, motivational practices at workplace, managing stress and work life balance.

**Unit IV** Group dynamics- types of groups, group formation, Group decision making, teambuilding and developing collaboration, leadership styles and influence process; leadership theories, leadership styles and effective leader.

**Unit V** Understanding and managing organisational culture, power and political behavior in organisations, conflict Management, negotiation, managing organizational change, concept of organisational development.

**Mgt.-502 Managerial Accounting and Control 2+1 Sem. I**

**Unit I** Financial Accounting- Meaning, Need, Accounting principles: Accounting Concepts and Conventions; Branches of Accounting, Users of Accounting information, Advantages and Limitations of Financial Accounting, Accounting Standards.

**Unit II** The Double Entry System- Its Meaning and Scope, The Journal, Cash Book, Ledger, Trial Balance, Trading Account Profit and Loss Account, Balance Sheet, entries and adjustments of different heads in different Books and Accounts, Introduction of Company Accounts, Use of Accounting Software.

**Unit III** Management Accounting-Meaning, Functions, Scope, Utility, Limitations and Tools of Management Accounting, Analysis of Financial Statements- Ratio, time series, common size and Dupont Analysis, Comparative and Common Size Statements, Cash Flow and Fund Flow Analysis.

**Unit IV** Cost Accounting–Nature, Course, Significance of Cost Accounting; Classification of Cost, Costing for Material; Labour and overheads; Marginal Costing and cost volume profit Analysis- Its Significance, Uses and Limitations; Standard Costing – Its Meaning, Uses and Limitations, Determination of Standard Cost, Variance Analysis-Material, Labour and Overhead.

**Unit V** Budget and Budgetary Control- Meaning, Uses and Limitations, Budgeting and Profit planning, Different Types of Budgets and their Preparations: Sales Budget, Purchase Budget, Production Budget, Cash Budget, Flexible Budget, Master Budget, Zero Based Budgeting. Mergers and Acquisition, Tax System- GST.

**Practical :** Numerical, Case Studies.

**Mgt.-503 Applied Managerial Economics** **2+0** **Sem. I**

**Unit I** Scope of managerial economics, objective of the firm and basic economic principles; mathematical concepts used in managerial economics. Introduction to behavioral economics.

**Unit II** Indifference curves and budget sets - Demand analysis - meaning, types and determinants of demand; demand function; demand elasticity; demand forecasting-need and techniques.

**Unit III** Production, cost and supply analysis- production function, Multi period production and cost least-cost input combination, factor productivities and returns to scale, cost concepts, cost output relationship, short and long-run supply functions.

**Unit IV** Pricing-determinants of price - pricing under different market structures, pricing of joint products, pricing methods in practice, government policies and pricing. Price discrimination (First, Second and Third level).

**Unit V** The national income; circular flow of income: consumption, investment and saving: money-functions, factors influencing demand for money & supply of money; inflation; economic growth; business cycles and business policies; business decisions under certain and uncertain situations.

**Mgt.-504 Human Resource Management** **2+0** **Sem. II**

**Unit I** Strategic Human Resource Management, Human Resource Planning-Nature and Significance, Job Analysis and talent management process, Job Description, job Specification, Job enlargement, Job enrichment, Job rotation.

**Unit II** Recruitment and Selection Process, Induction, Training and Human Resource Development-Nature, Significance, Process and Techniques, e- recruitment, use of Big Data for recruitment, use of Artificial Intelligence and machine learning tools in recruitment practices Career planning and Development Internal mobility including Transfers, Promotions, employee separation.

**Unit III** Performance Appraisal–Significance and methods, Compensation management, Strategic pay plans, Job Evaluation, Wage and Salary Administration; Wage Fixation; Fringe Benefits, Incentive Payment, bonus, and Profit Sharing.

**Unit IV** Role and Status of Trade Unions; Collective Bargaining; Worker's Participation in Management, employee retention. Quality of work life, employee welfare measure, work life balance, Disputes and Grievance Handling Procedures; Arbitration and Adjudication; Health and Safety of Human Resources.

**Unit V** Ethical issues in HRM, Managing Global Human Resources, Managing Human Resources in Small and Entrepreneurial firms, Human Resources accounting, Human Resources outsourcing. HR Information System, Human Resource Metrics and Workforce Analytics, Future trends in workforce technologies.

**Mgt.-505 Production and Operations Management** **2+0** **Sem. II**

**Unit I** Nature Concept and Scope of Production and Operations Management; Factors Affecting System; Facility location, Types of Manufacturing Systems and Layouts, Process Selection and Facility Layout, Layout Planning and Analysis, Forecasting.

**Unit II** Operations Strategy: Operations Strategy, Competitive Capabilities and Core Competencies, Operations Strategy as a Competitive Weapon, Linkage Between Corporate, Business, and Operations

Strategy, Developing Operations Strategy, Elements or Components of Operations Strategy, Competitive Priorities, Manufacturing Strategies, Service Strategies, Global Strategies and Role of Operations Strategy.

**Unit III** Productivity Variables and Productivity Measurement, Production Planning and Control, Mass Production, Batch Production, Job Order Manufacturing, Product Selection, Product Design and Development, Process Selection, Capacity planning.

**Unit IV** An Overview of Inventory Management Fundamentals, Determination of Material Requirement, Safety Management Scheduling, Maintenance Management Concepts, Work Study, Method Study, Work Measurement, Work Sampling, Work Environment, Production Planning and Control (PPC) Industrial Safety, human-machine interface, types of interface designs. Cloud operations management

**Unit V** Quality Assurance, Accepting Sampling, Statistical Process Control, Total Quality Management, ISO standards and their Importance, Introduction to re-engineering, value engineering, check sheets, Pareto charts, Ishikawa charts, JIT Pre-requisites for implementation Six Sigma, Lean Management, Reliability Engineering, Safety Engineering, Fault Tree Analysis.

**Mgt.-506 Marketing Management - I** **2+0** **Sem. I**

**Unit I** Introduction and Concept/ philosophies of Marketing Management; Product Management: The product, The product mix, Product line extensions, Product line deletions, Branding products, The advantages and disadvantages of branding, Branding decisions Brand loyalty models, Homogenous first-order Markov models, Higher-order Markov models Packaging, The functions of packaging, Packaging technology, Recent developments in packaging.

**Unit II** Pricing objectives, The laws of supply and demand, Elasticity of demand Cross-price elasticity of demand, Practical problems of price theory, Cost - revenue - supply relationships, The meaning of price to consumers, Price as an indicator of quality, Pricing strategies, Cost-plus methods of price determination, Breakeven analysis, Market-oriented pricing, Psychological pricing, Geographical pricing, Administered pricing.

**Unit III** Channel decisions in relation to marketing strategy, The value of middlemen, Key decisions in channel management, Types of distribution system, Marketing to middlemen, Power and conflict in distribution channels, Physical distribution, Customer service levels, Developing a customer service policy, The total distribution concept, Warehouse management, Inventory management, Calculating the economic order quantity, Transport management, Technological advances in physical distribution, Vehicle scheduling and routing, Fixed and variable routing systems, Vehicle scheduling tools, Vehicle scheduling models, Computer-based vehicle scheduling.

**Unit IV** The nature of marketing communications, Setting marketing communication objectives, Factors influencing the communications mix, The marketing communications mix, Advertising, Sales promotion, Public relations, Personal selling, Digital Marketing, Mobile Marketing, Social Marketing and Social Media Marketing, Training the sales force, Change agents, Selecting the media, Establishing the promotional budget, Monitoring the effectiveness of marketing communications.

**Unit V** Marketing Costs and Margins: Assessing the performance of a marketing system, Marketing efficiency and effectiveness, Operational efficiency, Pricing efficiency, Identifying marketing costs and margins, The reference products concept, Handling costs, Packaging costs, Transport costs, Storage costs, Processing costs, Capital costs.

**Mgt.-507 Marketing Management - II** **2+0** **Sem. II**

**Unit I** The importance of agricultural and food marketing to developing countries, the marketing concept and marketing systems, Marketing sub-systems, Marketing functions, Links between agriculture and the food industry, Agricultural and food marketing enterprises, Marketing boards in developing countries, Co-operatives in the agriculture and food sectors, Control and management of secondary co-operatives, The weaknesses of cooperatives, Selling arrangements between co-operatives and their members

**Unit II** Market Liberalisation: Economic structural adjustment programmes, Macroeconomic stabilisation, The role of the state in liberalised markets, Strategies for reforming agricultural marketing,

Obstacles to be overcome in commercialisation and Privatisation of agricultural marketing, Dealing with accumulated deficits, Encouraging private sector involvement in agricultural marketing, Impediments to private sector participation in agricultural markets, impact of the macro-economic environment on private traders, Government action to improve private sector performance.

**Unit III** Marketing Strategy, Planning and Control: Strategy, policy and planning, Strategic business units, The need for marketing planning, The process of marketing planning, Contents of the marketing plan, Monitoring, evaluating and controlling the marketing planning, Marketing controls, Marketing plan control, Efficiency control

**Unit IV** New Product Development: The impetus to innovation, New product development process The adoption process, The effect of products characteristics on the rate of adoption, Buyer behavior: The influences on buyer behaviour, Exogenous influences on buyer behaviour Endogenous influences on buyer behaviour, The consumer buying decision process, Buyer behaviour and market segmentation, Lifestyle segmentation, Organisational markets Industrial markets, Industrial buyer characteristics.

**Unit V** Stages in a commodity marketing system, Grain marketing, Challenges for grain marketing systems, fruits and vegetables, Livestock and meat marketing, Poultry and eggs marketing, marketing of fresh milk.

**Mgt.-508 Supply Chain Management** **2+0** **Sem. I**

**Unit I** Supply Chain: Changing Business Environment; SCM: Present Need; Conceptual Model of Supply Chain Management; Evolution of SCM; SCM Approach; Traditional Agri. Supply Chain Management Approach; Modern Supply Chain Management Approach; Elements in SCM. Innovations in Global Agri-SCM.

**Unit II** Demand Management in Supply Chain: Types of Demand, Demand Planning and Forecasting; Operations Management in Supply Chain, Basic Principles of Manufacturing Management. SCM Metrics/ Drivers and Obstacles.

**Unit III** Purchasing Cycle, Types of Purchases, Contract/Corporate Farming, Classification of Purchases Goods or Services, Traditional Inventory Management, Material Requirements Planning, Just in Time (JIT), Vendor Managed Inventory (VMI).

**Unit IV** History and Evolution of Logistics; Elements of Logistics; Management; Distribution Management, Distribution Strategies; Pool Distribution; Transportation Management; Fleet Management; Service Innovation; Warehousing; Packaging for Logistics, Third-Party Logistics (TPL/3PL); GPS Technology.

**Unit V** Concept of Information Technology: IT Application in SCM; Advanced Planning and Scheduling; SCM in Electronic Business; Role of Knowledge in SCM; Performance Measurement and Controls in Agri. Supply Chain Management- Benchmarking: introduction, concept and forms of Benchmarking. Case Studies on the following:(a) Green Supply Chains (b) Global Supply Chains (c) Coordination in a SC. Value of and distortion of information: Bullwhip effect (d) Sourcing and contracts in SC (e) Product availability with uncertain demand (f) Inventory planning with known /unknown demand (g) Cases from FAO/IFPRI etc.

**Mgt.-509 International Trade** **2+0** **Sem. II**

**Unit I** International trade–basic concepts, WTO and its implications for Indian economy in general and agriculture sector in particular.

**Unit II** TRIPS, TRIMS quotas, anti dumping duties, quantitative and qualitative restrictions, tariff and non-tariff measures, trade liberalization, subsidies, green and red boxes, issues for negotiations in future in WTO; CDMs and carbon trade.

**Unit III** Importance of foreign trade for developing economy; absolute and comparative advantage, foreign trade of India. Cases on commodity trade practices.

**Unit IV** India's balance of payments; inter regional Vs international trade; tariffs and trade control; exchange rate; the foreign trade multiplier.

**Unit V** Foreign demand, supply side analysis, opportunity cost, trade and factor prices, implications for developing countries, market entry methods, export procedures & documentations.

**Mgt.-510 Brand and Advertising Management** **2+0** **Sem. I**

**Unit I** Understanding brands: product versus brand, concept of a brand, brand perspectives. Brand attributes: significance of branding to consumers & firms, selecting brand names.

**Unit II** Brand awareness, types of brand awareness, preference analysis. Brand image- type of associations, brand identity, brand personality, product and brand positioning. Creating core brand values, 3Cs and positioning strategy. Perceptual mapping. Multi dimensional scaling system.

**Unit III** Sustaining brand equity: sources of brand equity, dimensions of brand equity. Managing brands: building branding strategies. Brand extensions and line extensions. Brand evaluation and brand revitalization. Co-branding, umbrella branding, brand licensing and franchising, global branding.

**Unit IV** Introduction, nature and purpose of advertising, advertising strategy planning. Advertising goals and objectives. Message strategy: copy writing, copy testing strategy. Media strategy: media budget, media vehicle decisions.

**Mgt.-511 Services Marketing** **2+0** **Sem. II**

**Unit I** Introduction to services marketing: Nature, concept and characteristics. Customer involvement in the services process. Targeting customers and managing relationships, complaint handling.

**Unit II** Positioning a service in the marketplace, Creating the service offering and adding value. Pricing strategies for services, Service promotion.

**Unit III** Planning and managing service delivery. Managing service quality. Balancing demand and capacity, managing customer waiting lines and reservations.

**Unit IV** Human resource management in service organisations, organising for service leadership, international and global strategies in service management. Technology and service marketing.

**Mgt.-512 Consumer Behavior** **2+0** **Sem. I**

**Unit I** Consumer behaviour: Origin and strategic applications, consumer research.

**Unit II** Consumer motivation. Personality and consumer behaviour. Consumer perception. Consumer learning. Consumer attitude formation and change. Communication and consumer behaviour.

**Unit III** Consumers in their social and cultural settings, reference groups and family influence, influence of social class, culture and subculture on consumer behaviour.

**Unit IV** Opinion leadership. Diffusion of innovation, diffusion process, the adoption process. Model of Consumer decision making.

**Mgt.-513 Retail Management** **2+0** **Sem. I**

**Unit I** Introduction to retailing- definition, concept and overview. Types of retail institutions. Targeting customers.

**Unit II** Store location and site selection. Human resource management in retail organization. Retail operations management.

**Unit III** Merchandise planning- inventory management and logistics. Inventory valuation. Forecasting and budgeting. Pricing strategy in retailing.

**Unit IV** Promotion strategy in retailing. Store design and layout- store and its image, store exterior, store interior, store layout, store display. Visual merchandise and atmospherics. Integrating and controlling the retail strategy.

**Mgt.-514 Managing Rural Markets** **2+0** **Sem. II**

**Unit I** Nature and magnitude of rural markets in India. Socio-cultural factors in rural marketing. Rural sales organization.

**Unit II** Special requirements for marketing in the rural areas with regard to product planning, communication channels, media and messages.

**Unit III** Marketing of agricultural inputs, distribution channels and systems, demand creation and market development, marketing of agri-inputs such as seeds, fertilizers, pesticides and farm machinery.

**Unit IV** Marketing of agricultural outputs. Determination of agricultural output and prices with special reference ACP Commission, systems of procurement- role of FCI and other procurement agencies, grading farm products, warehousing and cooperative marketing.

**Mgt.-515 Physical Logistics** **2+0** **Sem. II**

**Unit I** Concept and significance of physicals logistic and distribution system; marketing and physical distribution process, elements of physical distribution system.

**Unit II** Transportation and its relation to plant location.

**Unit III** Warehousing and inventory; modes of transportation optimum relationship between size and frequency of shipments; transportation model.

**Unit IV** Cost analysis and logistic system design. organization and management of physical distribution and logistic systems.

**Mgt.-516 Management of Financial Institutions** **2+0** **Sem. I**

**Unit I** Concept of capital market-role of specialized financial institutions and commercial banks. Consideration of bank functions, objectives, policies, organizations.

**Unit II** Management of primary and secondary reserves cash management and portfolio management; management of loans and advances, credit analysis and control.

**Unit III** Tandon Committee and Chore Committee recommendations for Bank Financing. Management of funds and income, deposit and deposit mobilization, profitability analysis of commercial banks, management control and appraisal-transfer price mechanism, performance budgeting.

**Unit IV** Evaluation of bank performance. Genesis of specialized financial institutions- IDBI, IFCI, ICICI, UTI, NABARD, LIC, SFCs and Sides -a brief overview of their objectives, functions and role, adequacy of capital and strategy of growth.

**Mgt.-517 Management Control Systems** **2+0** **Sem. I**

**Unit I** Functioning and structure- nature, functioning and objectives of control systems-strategic planning, management control and operational control, organizational relationships in management control.

**Unit II** Behavioral implications, motivation and goal congruence, management control structure-decentralization, responsibility centres-expense, profit and investment centres.

**Unit III** Control process, budgeting and budgetary control, types of budgets and their preparation. Installation and evaluation of comprehensive budgeting control system.

**Unit IV** Standard costing and budgetary control. Analysis and reporting performance. Special management control situations-service organization, non-profit organizations and control of projects.

**Mgt.-518 Management of Financial Services** **2+0** **Sem. I**

**Unit I** Indian financial system - introduction, structure.

**Unit II** Non banking finance companies- introduction, RBI Act framework. Asset liability management system.

**Unit III** Leasing- concept, classification, significance and limitations. Financial Evaluation. Hire purchase finance and consumer credit- conceptual framework. Financial Evaluation. Factoring and forfeiting. Bill discounting- concepts, advantages.

**Unit IV** Housing finance- NHB, system. Refinance schemes, securitisation, mortgage based securitisation, reverse mortgage scheme. Insurance- life and general products and concepts.

**Unit V** Mutual funds- concept and classification, advantages and mutual fund performance. Bonds- bond terminology, bond types, Indian bonds market. Issue management intermediaries, activities/ procedures, pre-issue and post-issue obligations and requirements. Commodity markets and products.

**Mgt.- 519 Investment Management** **2+0 Sem. I**

**Unit I** Investment objectives and constraints, types of investors. Investment analysis and stock exchanges in India.

**Unit II** Market efficiency, modern portfolio theory, types of investment products.

**Unit III** Security analysis- quantitative and qualitative variables, fundamental and technical analysis techniques, fixed income securities

**Unit IV** Portfolio management and performance measurement, derivative products - futures and options.

**Mgt.-520 International Financial Management** **2+0 Sem. II**

**Unit I** Financial management in a global context. The nature and measurement of exchange rate. Exposure and risk- approach, classification, treatment, interest rate exposure and risk.

**Unit II** The international monetary system- exchange rate regimes, IMF and EMU.

**Unit III** The foreign exchange market- structure, transaction types, quotations, arbitrage, pricing, foreign exchange market in India. Financing of foreign trade operations.

**Unit IV** Currency and interest rate futures- introduction, contracts, markets, trading, future prices, spot and forward prices, Hedging and speculation. Currency options - terminology, quotations, hedging, pricing models, embedded options and currency options in India. Interest rate FRAs.

**Mgt.-521 Tax Planning** **2+0 Sem. II**

**Unit I** Concepts and significance of tax planning, tax evasion and avoidance.

**Unit II** Tax environment, implications and their impact on financial decision making and enterprise behavior.

**Unit III** Fiscal policy and impact of central and state budgets, taxes under the jurisdiction of Union and state governments classification of taxes.

**Unit IV** Salient features and main legal provisions of income tax and other acts relating to incentives and concessions. Tax planning for individuals and corporate sector.

**Mgt.-522 Production Planning and Control** **2+0 Sem. I**

**Unit I** Nature and objectives of production planning and control, variables subject to control. Production control for continuous, intermittent and project systems.

**Unit II** Learning curve effects, production forecasting and production inventories. Aggregate planning guidelines, graphic and charting methods, mathematical planning models.

**Unit III** Scheduling philosophy, scheduling methodology and control techniques.

**Unit IV** Development of means to reporting production and comparison of schedule with actual performance development of standards.

**Mgt.-523 Econometrics** **2+0 Sem. I**

**Unit I** Introduction - relationship between economic theory, mathematical economics, models and econometrics. Methodology of econometrics. Representation of economic phenomenon, relationship among economic variables, linear and non-linear economic models.

**Unit II** Analysis of economic time series components and their interpretation. Ordinary least squares methods of estimation of simple and multiple regression models. The BLUE properties of least squares estimate, tests of significance and confidence intervals. Indirect least square method of estimation.

**Unit III** Maximum likelihood estimation. Problems of multicollinearity, heteroscedasticity and auto-correlation. Principal component analysis, use of dummy variables. Generalized Aitkin's least squares methods of estimation.

**Unit IV** Distributed lag models. Estimation from grouped data. Application of computer software for solving practical econometric problems. Simultaneous equation models structural equations, reduced form equations, identification and approaches to estimation.

**Mgt.-524 Cost Control and Value Analysis** **2+0** **Sem. I**

**Unit I** Cost control concepts-components, types and control. Budgets-fixed and flexible, cost standards, labour costs, material costs and overhead costs.

**Unit II** Analysis of cost variance labour variance, material variance and overhead variance. Cost reporting and correction.

**Unit III** Principles and techniques of cost reduction. Basic concepts and value engineering, historical perspectives, functions and value. Job plans, fast diagrams and other value engineering tools.

**Unit IV** Behavioral and organizational aspects of value engineering, benefits of value engineering.

**Mgt.-525 Work Study** **2+0** **Sem. II**

**Unit I** Work measurement, work simplification or reduction of human effort through simplifying, combing, eliminating or changing processes.

**Unit II** Study of process charts, study of symbols including therbligs.

**Unit III** Meaning of effecting work simplification through time and motion study.

**Unit IV** Development of standard method's and standard times for all operations.

**Mgt.-526 Operations Management** **2+0** **Sem. II**

**Unit I** Planning and organization of operations, operations management concepts.

**Unit II** Material and equipment inputs, human resource inputs and capital inputs.

**Unit III** Directions and control of operations, product and process analysis.

**Unit IV** Forecasting various control techniques including inventory, quality, maintenance and cost control. Operating environment.

**Mgt.-527 Purchasing and Materials Management** **2+0** **Sem. II**

**Unit I** Fundamentals of purchasing and materials management, determinants of right materials.

**Unit II** Quality specifications and standardization, reliability and inspection, price, service and delivery.

**Unit III** Sources of supply, make or buy decisions, inventory control systems.

**Unit IV** Value analysis/engineering, management of procurement and materials activities.

**Mgt.-528 Personnel Management Practices** **2+0** **Sem. I**

**Unit I** Role of personnel manager in organisation, status and background and personnel managers.

**Unit II** Personnel policies framework, formulation and execution of policies relating to major personnel functions, current development and role of social and demographic factors in personnel functions. Industrialization - its growth implications and problems.

**Unit III** Role of industrial psychology in Job analysis and personnel testing. Performance appraisal, training and development, job and work situation and job satisfaction.

**Unit IV** Current developments and personnel practices on effective functioning of an organisation.

**Mgt.-529 Human Resource Development** **2+0** **Sem. I**

**Unit I** Concept, significance and mechanisms of HRD. Line managers and HRD, Developmental supervision, Management development and HRD.

**Unit II** Motivational aspects of HRD. Career planning and development, performance management.

**Unit III** Executive training- methods and evaluations of training programme.

**Unit IV** Organization development (OD) and HRD-components, process and technology of OD, team building.

**Mgt.-530 Industrial Relations in India** **2+0** **Sem. I**

**Unit I** Industrial relations, role of government in IR and industrial conflicts, code of discipline, standing orders, grievance handling.

**Unit II** Mediation, conciliation, adjudication, arbitration, trade unions and industrial relations, collective bargaining, industrial democracy.

**Unit III** Labour welfare-concept, nature and types of welfare plans, welfare administration. Welfare legislation -social security administration. Industrial relations in western countries.

**Unit IV** Industrial relations in public and private sectors in India. Problems of industrial relations at major industrial towns.

**Mgt.-531 Business Ethics and Indian Management** **2+0** **Sem. II**

**Unit I** Societal concept and social responsibility of business: spectrum of social issues-conservation of natural resources, pollution control and other environmental issues.

**Unit II** Fair business practices, human resources, consumer and community involvement.

**Unit III** Business ethics and unethical behaviour of managers. Ethical code and legal requirements in different areas.

**Unit IV** Ethical pressure points, pressure from superiors, comparative conceptual disparity and ambiguous situations.

**Mgt.-532 Industrial and Labour Laws** **2+0** **Sem. II**

**Unit I** Concept of labour welfare and role of industrial and labour legislation, safety and welfare legislation.

**Unit II** Factories Act, Workmen's Compensation Act, Minimum Wages Act, Employees State Insurance Act.

**Unit III** Employees Provident Fund Act, Employees Family Pension Scheme.

**Unit IV** Maternity Benefit Act, Payment of Bonus Act, Trade Union Act. Administration and labour laws.

**Mgt.-533 Farm Business Management** **2+0** **Sem. I**

**Unit I** Nature, scope and functions of farm business management.

**Unit II** Working out existing and alternative farm plans, farm labour.

**Unit III** Farm capital and its problems, farm machinery and its utilization.

**Unit IV** Decision making process in farm management, management of other special farm projects like poultry, dairy, fishery, bee-keeping and piggery, farm forecasting and other special managerial problems of farms.

**Mgt.-534 Management of Cooperatives** **2+0** **Sem. I**

**Unit 1** Nature of cooperative principles, management principles and their applications to cooperative organizations.

**Unit II** Structure and functions of various types of cooperatives, managerial problems of cooperatives, role of government.

**Unit III** Financing of cooperatives, staffing and training, price, output and profit policies of cooperatives.

**Unit IV** Special problems of cooperatives in agricultural sectors, management practices of successful cooperatives in India.

**Mgt.-535 Agricultural Marketing** **2+0** **Sem. I**

**Unit I** Advanced study of organization and function of agricultural marketing in India. Market structure and performance, determination of price and marketing margins, distribution.

**Unit II** Warehousing and cooperative marketing; methods of grading of farm product-market grades, magnitude and dimensions of marketed and marketable surplus of agricultural commodities.

**Unit III** Efficiency of marketing, storage, transportation and financial management in agricultural marketing.

**Unit IV** Perishability, seasonality and processing of different agricultural products, pricing of processed products and demand creation.

**Mgt.-536 Strategic Management** **2+0** **Sem. II**

**Unit I** Introduction - Concepts in Strategic Management, Strategic Management Process; Corporate Governance, Social Responsibility and Ethics in strategic management, Environment Scanning and Industry analysis.

**Unit II** Organization appraisal and strategy formulation: organizational dynamics and structuring organizational appraisal, business models and Value chain analysis, Strategy formulation- corporate level strategies and business strategies, Generic Strategies- Types of Strategies, tools and techniques for strategic analysis.

**Unit III** Turnaround and Diversification Strategies: Turnaround strategy - Management of Strategic Change, Strategies for Mergers, Acquisitions, Takeovers and Joint Ventures - Diversification Strategy.

**Unit IV** Strategy implementation and control: aspects, structures, design and change: behavioural implementation-leadership, culture, value and ethics, strategic evaluation and control-an overview and techniques of strategic evaluation and control. UNIT V: Strategic issues in managing technology & innovation, entrepreneurial ventures and small businesses, Cases in strategic management.

**Mgt.-537 Operations Research in Business** **2+0** **Sem. II**

**Unit I** Linear Programming: Objective, Assumptions, Formulation of Linear Programming Problem, Data Envelopment Analysis, Graphic Method, Simplex method, Introduction to Dynamic Programming, Transportation and Assignment Problems.

**Unit II** Inventory control Models: Costs Involved in Inventory Management, Types of Inventory, Economic Order Quantity (EOQ) Model, Continuous Review (Q) System, Periodic Review (P) System, and Hybrid System.

**Unit III** Waiting Line Models: Waiting Line Problem, Characteristics of a Waiting- Line System, Single-Channel Model, Multiple-Channel Model, Constant-Service Time Model, Finite Population Model, Sequencing and Replacement models.

**Unit IV** Decision making under Risk and uncertainties, Decision problem, Maximax Criterion, Maximin Criterion, Minimax Regret Criterion, Laplace Criterion, Pay off Tables, Decision Trees, Expected Value of perfect Information, stochastic models, neural networks, Markov process.

**Unit V** Game Theory - Two -Person Zero-Sum Game, Simulation, Network analysis–PERT& CPM. Financial Engineering.

**Mgt.-538 Financial Management** **2+0** **Sem. II**

**Unit I** Meaning, importance, nature and scope of financing in India, business financing in India; classification and credit need in changing business scenario; finance functions, investment financing, Risk and return concept & analysis.

**Unit II** Business Financing System in India, Money and Capital Markets, Regional and All - India Financial Institutions; venture capital financing and its stages, International financial management.

**Unit III** Features, types and Techniques of capital budgeting decision. Cost of Capital, Leverage analysis, Capital structure. Theory and Policy, Sources of Long and Short term finance, Dividend Theory, Dividend Policy.

**Unit IV** Management of Working Capital, Management of Receivables, Management of cash; Cash budget, Management of collections and disbursement, Investment of Surplus cash.

**Unit V** Perspectives and operational aspects of Micro finance: Definition, Scope and importance of Micro Finance, Evolution of Micro Finance in India, Micro Finance credit lending models:- Association model, Community Banking model, Credit union model, Cooperative model, SHG model, Village Banking model.

**Mgt.-539 Communication for Management** **2+1** **Sem. I**

**Unit I** Communication process, barriers to communication, methods of communication, effective communication, assertive communication, types of organisational communication. Listening skills, active listening, barriers to effective listening, Non Verbal Communication.

**Unit II** Reading comprehension and techniques, rules of good writing, business letter writing, email writing, crafting messages for electronic media, social media, business blogs, podcasts, employment messages.

**Unit III** Visual presentation, oral presentation skills, conducting business meetings, brainstorming sessions and presentations, public speaking skills, Communicating across cultures, Various forms of scientific writings, theses, technical papers, reviews, manuals, research work, various parts of thesis and research communication Title page, authorship, contents, preface, introduction, review of literature, material and methods, experimental results and discussion, Technical Writing Style and Editing, Writing Introductions & Conclusions, Editing and Proof reading, Writing a review article and book summary.

**Unit IV** Developing interpersonal skills (transactional analysis), Business Etiquettes, essentials of business conversations. Business meeting agenda and minutes, circulars and sales letters, notices, overview of business proposals

**Unit V** Developing self-awareness (Johari Window), solving problems analytically and creatively, introduction to case method of learning, case reading, approaches and analysis.

**Practical :** Case Studies and Group Exercises in Communication.

**Mgt.-540 Research Methodology for Management** **2+1** **Sem. II**

**Unit I** Meaning, Course Objective, types, and process of research; research methodology in management- exploratory, descriptive, experimental, diagnostic, Problem formulation, setting of Course Objective, formulation of hypotheses, models, types of models, process of modeling.

**Unit II** Scales of measurement - nominal, ordinal, interval, ratio, Likert scale and other scales; Primary and secondary data, sources of data, Questionnaire Designing, instruments of data collection, data editing, classification, coding, validation, tabulation, presentation, analysis, development process of scale, identification of variables, variable measurement, variable standardization and dummy variables.

**Unit III** Introduction to multivariate statistical analysis techniques, Multivariate linear regression models, principal component analysis, linear discriminant analysis, factor analysis, evaluation matrices and model diagnostics for regression models.

**Unit IV** Logistic regression, decision trees, cluster analysis, random forest, GARCH, CART models, support vector machines, Forecasting techniques (AR, MA, ARMA and ARIMA models).

**Unit V** Definition, scope and importance, machine learning, types of machine learning, linear and nonlinear models in machine learning, introduction to deep learning, basic differences in machine learning and deep learning, concept of cloud machine learning, Big data analysis.

**Practical :** Numericals, Case Studies and Group Discussions.

**Mgt.-541 Computer Applications for Business** **2+1 Sem. I**

**Unit I** Concept of Computers- Brief History of Computers, Generation and Its Evolution, Characteristics of Computers, Main Areas of Computers and their Applications; Classification of Computers, Input-Output Devices, Memory Types (Cache, RAM, ROM), Memory Units.

**Unit II** System Software and Application Software, Opensource software, introduction to computer languages, Introduction to Operating Systems – Functions, Features and Types., MS Windows and LINUX. Data Base Management System, MS Office (MS Word, MS Power Point, MS Excel, MS-Access and use of various management software Like SPSS, SAS etc.

**Unit III** The business value of internet, Intranet, extranet and Internet, Introduction to Web page design using HTML, Cloud Computing, Security and ethical challenges: Computer crime – Hacking, cyber theft, unauthorized use at work. Piracy – software and intellectual property. Health and Social Issues, Ergonomics and cyber terrorism.

**Unit IV** The concept of MIS–Definition, importance, Course Objective, prerequisites, advantages and challenges; Information Needs of organization, MIS and Decision – Making. Types/Classification of Information System for organizations; Introduction to Artificial Intelligence (AI), Neural Networks, Fuzzy logical control systems

**Unit V** e business/ e commerce: e business models, e commerce processes, electronic payment systems, e- commerce trends with special reference to agri business. Applications of MIS in the areas of Human Resource Management, Financial Management, Production/Operations Management, Materials Management, Marketing Management.

**Practical :** Computer Exercises.

**Mgt.-542 Project Management and Entrepreneurship** **2+1 Sem. II**

**Unit I** Concept, characteristics of projects, types of projects, project identification, and Project's life cycle. Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis.

**Unit II** Network Methods: Meaning, Network Analysis, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), Project scheduling and resource allocation. Financial appraisal/evaluation techniques- discounted/non-discounted cash flows; Net present values, profitability index, Internal rate of returns; Cost benefits ratio; Accounting rate of return, Payback period, Project implementation; Cost overrun, Project control and information system.

**Unit III** Concept of Entrepreneurship: Objective, Introduction to entrepreneurship, Entrepreneurial Development Models, Successful Models in Entrepreneurship Intrapreneur, Development of women entrepreneurship with reference to SHGs, Social entrepreneurship.

**Unit IV** Creativity, Innovation and Entrepreneur: Inventions and Innovation, The Environment and Process of Creativity, Creativity and the Entrepreneur, Innovative Approaches to Entrepreneurship, Business Incubation, Steps and Procedure to start a new business, Business Opportunities in different Sectors.

**Unit V** Sources of Financing, Structure and Government Policy Support: Estimating Financial Requirements, Preparation of Detail Project Report, Project Appraisal, Sources of Long Term Financing, Working Capital Financing, Venture Capitalist, Finance from Banking Institutions, Industrial Policy Resolutions in India, Incentives and Subsidies, Schemes for Incentives, Government Organisations like SIDO, DIC, KVIC, NSIC, SIDBI, NABARD and their role, Sick Industries and their Up gradation policy measures.

**Practical :** Case Studies, Group Discussions, Preparation of Business Plan.

**Mgt.-543 Business Environment** **2+0 Sem. II**

**Unit I** Business and its environment: nature, and importance, types of environment, environmental factors, environmental analysis and environmental scanning.

**Unit II** Economic environment of business: nature and structure of economy. Globalization and WTO- it's impact on economy. Government policies- industrial policy, monetary policy.

**Unit III** Fiscal policy, union budget. Social Environment: social responsibility of business and business ethics, corporate governance.

**Unit IV** Political environment of business. Legal environment. Technological environment- technology development and transfer.

**Mgt.-544 Business Laws and Ethics** **2+0** **Sem. I**

**Unit I** Introduction to Indian legal system, The Indian Contract Act-1872: Contract meaning, types of contract, essentials of a valid contract, offer and acceptance, capacity to contract, free consent, performance of contract.

**Unit II** Law of Negotiable Instruments: Promissory Notes, Bills of Exchange, Cheques and Bank Drafts, Endorsements, Law of Sale of Goods, Sales of Goods Act-1930-: Sale and agreement to sale, types of goods, Transfer of property in goods, mode of delivery of goods, performance of contract of sales, rights of an unpaid seller.

**Unit III** Companies Act-1956: incorporation, commencement of business, types of companies, management of company, Memorandum of Association and Articles of Association, prospectus, winding of companies.

**Unit IV** Essential Commodities Act, Consumer Protection Act, RTI Act, MRTP Act major provisions and implications. Competition Act-2002, Regulatory environment for International Business

**Unit V** Nature and importance of ethics and moral standards; corporations and social responsibilities, scope and purpose of business ethics; Ethics in business functional areas; industrial espionage; solving ethical problems; governance mechanism. implementing business ethics in a global economy.

**Mgt.-545 Rural Finance** **2+0** **Sem. II**

**Unit I** Functions, structure and working of rural financial market in India.

**Unit II** Role of rural financing institutions like NABARD, RRBs.

**Unit III** Credit policies of various financing institutions.

**Unit IV** Agricultural credit policy since independence, innovative financing, intensive financing, village adoption.

**Mgt.-546 Management of Strategic Organizations** **2+0** **Sem. II**

**Unit I** Concept and significance of strategic organizations, public sector enterprises.

**Unit II** Sunrise industries, research and training institutions, staffing and training.

**Unit III** Efficiency criteria, public accountability, motivation.

**Unit IV** Control and leadership in strategic organizations with special reference to public sector enterprises and developmental agencies.

**Mgt.-547 Management of Agro-Industrial Projects** **2+0** **Sem. II**

**Unit I** Nature of agro-industrial projects. Formulation of agro-industrial projects - economic, technical and financial feasibility.

**Unit II** Generation of alternative project ideas and preliminary screening; methods for evaluation and ranking of projects.

**Unit III** Preparation of feasibility report, financing of agro-industrial projects, sources of finance and structure of financial institutions, central and state incentives.

**Unit IV** Implementation of project, organization viability, management control and information system, monitoring and feedback, operational problems in implementation of projects.

**Mgt.-548 Management of Research and Development** **2+0** **Sem. II**

**Unit I** Role of research and development activities within business enterprises.

**Unit II** Effective management of research and development functions - determining research and development needs of organization.

**Unit III** Establishing priorities, developing R & D plans and strategies, preparing budgets, characteristics of effective R & D programmes.

**Unit IV** Personnel, financial and accounting control, schedule control, project evaluation and corrective action.

**Mgt.-549 Managing E-Business** **2+0** **Sem. I**

**Unit I** E-marketing, Digital Marketing, E-commerce and E-business. A Strategic Approach to Digital Marketing. Micro and Macro environment in Digital marketing.

**Unit II** Digital Marketing Strategy. Digital marketing mix. E-CRM.

**Unit III** Delivering the Online Customer Experience. Interactive Marketing Communications.

**Unit IV** B2B and B2C Internet Marketing. Security Issues.

**Mgt.-550 E-Commerce Technologies** **2+0** **Sem. I**

**Unit I** Introduction to Internet and intranet, www (Network essentials, HTML. Introduction to Protocols and services).

**Unit II** Concepts: working, surfing and security on the internet. Web : worldwide web, advantages of web, web terminology, web access using browsers and search engines.

**Unit III** Introduction to various E- commerce technologies, E-Commerce transactions. Strategies, issues and remedies.

**Unit IV** Study of different types of browsers. Sending and receiving E-Mails. Assessing files with FTP. Viewing and using graphic files. Working with newsgroups, real time chat on internet and intra-net.

**Unit V** Selecting an internet service provider. Transfer of information on internet and intranet. Private virtual networks. Net phones. Client server architecture, work load distribution. Application of E-Commerce technologies for business decisions.

**Mgt.-551 Data Management for Decision Makers** **2+0** **Sem. II**

**Unit I** Introduction to data and its concepts. Basic concepts. Entities and their attributes, relationship, records and files. Abstraction and data integration.

**Unit II** Proposal for DBMS, data independence, components of DBMS, advantages and disadvantages of DBMS. Data models: Relational, Hierarchical and Distributed.

**Unit III** Relational Data Model: Relational databases - attributes and domains, relation and their schemes. Relations representation, key relationship, relation operations, integrity rules. Data reliability and authenticity. Entity relationship, data processing and report generation. Data definition, view and queries: types (individual and form based).

**Unit IV** Data protection: recovery, concurrency, security, integrity and control of information, data encryption. Debugging and performance evaluation of software, software documentation. Development of online help. Introduction to ERP.

**Mgt.-552 Current Issues in E-Business** **2+0** **Sem. II**

**Unit I** Latest developments in the area of e-business/e-commerce and e-governance including technical, legal and behavioural issues.

**Unit II** Impact of these issues in the overall business environment and emergence of various opportunities and threats.

**Mgt.-591 Seminar** **1+0** **Sem. I**

**Mgt.-595 Summer Internship** **0+4 NC** **Sem. II**

**Mgt.-599 Project Work** **0+10 NC** **Sem. I / II**

## Ph.D. Courses

**Mgt.-601 Econometrics for Business** **2+1 Sem. II**

Introduction: Correlation theory, Basic concept of regression analysis, assumptions of regression model, theory of OLS, properties of least square estimates, maximum likelihood, hypothesis testing, interval estimation, prediction in linear regression model. Heteroskedasticity and autocorrelation, multicollinearity, specification errors, selection of regressors, dummy variables, autoregressive and distributed models. Set of regression equations, causality and simultaneity: application. Time series econometrics- stationarity, unit roots and co-integration, error correction model, AR, MA, ARMA, ARIMA processes. Qualitative dependent variables – LPM, Logit and probit models.

**Practical :** Numerical, Case Studies.

**Mgt.-602 Research Methods I** **2+1 Sem. II**

Translating problems to research issues: Selection of qualitative vs quantitative research definitions, objectives, research methodologies rationale, sample/sources of data, data collection techniques, Questionnaire designing: use of measurement and scaling techniques, reliability testing. Fieldwork: Data collection, gaining access and entry, ethical considerations, identifying key informants, validation and evaluation of fieldwork, data preparation, field notes and recording. Hypothesis Development and Theoretical Modelling. Business Analytics, Business Intelligence. Types of Business Analytics, Introduction to predictive modelling/analytics. Linear programming, Contemporary applications of marketing research.

**Practical :** Business Analytics Exercise, Case Studies.

**Mgt.-603 Management thought and Comparative Management** **2+1 Sem. II**

Early contributions to development of management thought. Contributions of important thinkers such as Frederick Taylor, Henry Fayol, Gilbreth, Mary Parker Follett, Elton Mayo, C. I. Barnard, A. P. Sloan, Max Weber and others. Human Relations Approach, Behavioural Science Theorists, Quantitative Approach, Systems Approach, Contingency Approach and Process Approach to management. Need, importance and scope of comparative management. Impact of national and cultural differences on management. Management in different economic systems-Chinese, Japanese, American and Indian. Globalization and management convergence, Managing and developing cross cultural organizations, Hofstede's cultural theory. Management in public sector and third sector organisations.

**Practical :** Case Studies.

**Mgt.-604 Research Methods II** **2+1 Sem. I**

Hypothesis testing, Analysis of variance and covariance, Correlation and regression, Discriminant and Logit analysis, Factor analysis, Cluster analysis, Multidimensional scaling and conjoint analysis. Data Mining, Data Mining Methods—Data Dredging, Data Fishing, Data Snooping and Process Mining—Business Process Discovery, Conformance Checking and Model Enhancement. Arena Modelling. Applications of Statistical Softwares like SAS, Modelling with statistical softwares. Report preparation and presentation, International Marketing Research.

**Practical :** Data Mining Exercise, Case Studies.

**Mgt.-605 Advanced Financial Management** **2+0 Sem. I**

An integrated view of financial decisions, investment decisions and dividend decisions of firm. Dividend policy. Maximizing owners' wealth and its impact on market price. Retention and dividend decisions. A critical evaluation of dividend policies of Indian firms. Financial structure of firm. Financing Decisions and valuation of firm. Appraisal of valuation formula, optimum financing decisions under conditions of certainty, risk and uncertainty.

**Mgt.-606 Knowledge Management** **2+0 Sem. I**

The Knowledge Economy: Leveraging Knowledge, Data-Information knowledge-Wisdom relationship, organizational knowledge, characteristics and components of organizational knowledge –Building knowledge societies- Measures for meeting the challenges of implementing, KM programmes. Knowledge

Management and Information Technology: Role Information Technology in Knowledge Management Systems, Knowledge Management tools, Creative effective Knowledge Management Systems through Information Technology, ERP and BPR, Data Warehousing and Data Mining. Future of Knowledge Management and Industry perspective: Companies on the road to knowledge management, Knowledge Management in Manufacturing and service industry, challenges and future of Knowledge Management. The Knowledge Process: Universal appeal, Stages of KM Process, Knowledge Capital vs physical capital, Customer Relationship Management, Business Ethics And KM, The Promise of Internet and the Imperatives of the new age. Implementation of Knowledge Management: Discussion on Road Blocks to success, Business Intelligence and Internet platforms, web Portals, Information Architecture: A three-way Balancing Act, KM, the Indian experience, Net Banking in India. –Role of knowledge Management in Organisational Restructuring. -The Mystique of a Learning Organisation.

**Mgt.-607 Management Information and Control Systems** **2+0** **Sem. I**

Management information systems - perspectives, management information needs, purpose, scope, design of management information systems, need for control, implementing management information systems, problems and pitfalls, managerial interference, technology and foundation of management information systems. Management Control Systems profit planning and control, sales, production and expenses, performance reports for management control.

**Mgt.-608 Entrepreneurship and Corporate Governance** **1+0** **Sem. II**

Nature of Entrepreneurship: Concept, knowledge, skills requirement and functions; characteristic of successful entrepreneurs; scenario in India and Abroad, entrepreneurship process; factors impacting emergence of entrepreneurship; managerial vs. entrepreneurial approach and emergence of entrepreneurship, Risk Reduction strategies. Starting the venture: generating business idea – sources of new ideas, methods of generating ideas, SWOT Analysis, environmental scanning, competitor and industry analysis; feasibility study – market feasibility, technical/operational feasibility, financial feasibility; drawing business plan; preparing project report; presenting business plan to investors. Functional plans: marketing plan – marketing research for the new venture, steps in preparing marketing plan, contingency planning; organizational plan – form of ownership, designing organization structure, job design, manpower planning; Financial plan – cash budget, working capital, proforma income statement, proforma cash flow, proforma balance sheet, break even analysis. Sources of finance: debt or equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs, Government Grants and Subsidies, Entrepreneurship Promotion Schemes of Department of Industries (DIC), KVIC, SIDBI,NABARD, NSIC, APSFC, IFCI and IDBI etc. ; legal issues – intellectual property rights patents, trademarks, copy rights, trade secrets, licensing; franchising. Necessity for Business Ethics- Salient Issues in Ethics and Commerce- Shadow Economy – Basic Principles in Ethics –Corporate Climate and corporate climate audits – Political Issues – Nature and theory of Ethics, Corporate Governance- Historical perspective and issues of Corporate Governance –Corporate Governance mechanisms – Corporate Governance Models, – The confederation of Indian Industry's initiative.; Corporate Social Responsibility.

**Mgt.-609 Advanced Accounting Theory and practice** **2+0** **Sem. I**

Accounting theory and accounting profession, accounting objectives, concepts, measurements and structure of accounting theory, international accounting standards, concepts of income reporting. Theoretical evaluation of revenues and expenses, gains and losses, business income and price changes. Valuation of assets, depreciation and human resource accounting. Company accounts, allotment, transfer and forfeiture of shares. Appropriation of profit, acquisition, amalgamation and absorption of business, reconstruction.

**Mgt.-610 Communication for Management Teachers** **0+2** **Sem. I**

**Practical**: Management education- Action gaps in education and latest developments and required skills. Communication: Active listening, group communication, Language process. Presentation on readings-recorded and graded: Oral presentation & computer assisted presentations. Theory and techniques: Didacticism, Group work & discussion method, Simulation, facilitation skills and styles for experiential learning. Emotional perspective in teaching. Learning in management education: Experiential learning,

Action Learning, Group learning, Simulation and games, Role Play, Teaching and learning through Electronic Media. Case method of teaching: Writing a case and teaching note, Critiquing a research article

**Mgt.-611 International Financial Management** **2+0** **Sem. II**

Financial problems of multinational corporations in different environment. Evaluation of direct investment opportunities and financial planning and control of multinational corporations. Criteria for selection of investments, outlets in foreign countries. Multinational capital budgeting, working capital management, sources and instruments of international finance planning; subsidiaries, financial structure. Consolidation of financial reports of subsidiaries and parent corporations. Financial problems of joint ventures. Management of international fund movements

**Mgt.-612 Financial Reporting** **2+0** **Sem. II**

Financial reports - general and special purpose. Regulations regarding disclosures of public sector enterprises, nature of disclosures, standards for disclosures, accounting problems of disclosure. Financial management - reports of board of Directors, Chairman's speech, supplementary statements, schedules, footnotes etc. Disclosure of non-financial information. Disclosure of multi-unit and diversified firms, financial disclosures of Indian companies

**Mgt.-613 Statutory Cost and Management Audit** **2+0** **Sem. I**

Auditing philosophy, audit objectives and techniques, principles of auditing, methodology of audit, audit programme design, audit of cash and trading transactions, audit of impersonal and personal ledgers, balance sheet audit, verification and investigation of assets. Rights, duties and responsibilities of an auditor. Independence in audit, concentration of audit, statistical sampling techniques and auditing. Cost audit-principles and procedure, audit and internal control, audit reporting problems. Management audit - problems in developing performance standards, management audit procedures and reporting on management audit

**Mgt.-614 Portfolio Management** **2+0** **Sem. II**

Concepts of portfolio management, strategy of risks and returns, different approaches to portfolio management, personal portfolio management. Portfolio management of investment companies, trusts, commercial banks, development institutions, insurance companies and pension funds. Role of computer in portfolio management

**Mgt.-615 Advanced Marketing Management** **2+0** **Sem. I**

Innovative marketing. Marketing information. Marketing Productivity. Product and Service Analytics. Price analytics. Distribution analytics. Sales Analytics. Model building for analysis and interpretation of marketing data. Deterministic optimising models. Stochastic process models. Experimental designs. Discriminant and canonical analysis, Factor and cluster analysis.

**Mgt.-616 Marketing Strategy** **2+0** **Sem. II**

Market-driven strategy. Principles of Marketing Planning. Corporate, Business and marketing strategy. Markets and competitive space. Forecasting. Strategic market segmentation. Market targeting and Strategic Positioning. Strategic Brand management. Value-Chain strategy. Pricing strategy. Promotion strategy. Implementation of marketing strategies- organization system, testing a plan, performance analysis, efficiency control and marketing audit.

**Mgt.-617 Retail and Wholesale Management** **2+0** **Sem. I**

Brief introduction to marketing channels, concept of wholesaling, functions of wholesaler, types of wholesalers, trends in wholesaling. Introduction to retailing. Retail models and theories of retail development. Types of retail institutions. Strategic planning in retailing, targeting customers. Store location and site selection. Human resource management in retail organizations. Merchandise planning – Inventory management and logistics. Pricing strategy in retailing. Store atmospherics, store layout, design and visual merchandising. Promotion strategy in retailing. Innovation and change, emerging trends in retailing.

**Mgt.-618 Marketing Legislation in India** **2+0** **Sem. II**

Various central and states statutes and legislation. Evolution of various governmental regulations. Selected statutes such as MRTP Act, Essential Commodities Act. Quality, Price and Distribution Control Legislation, Pure Food Legislation, Trade Mark, Copyright and Patent Legislation.

**Mgt.-619 Financial Strategies for Marketing Operations** **2+0** **Sem. I**

Analytical and creative approach to financial dimensions of marketing decisions. Setting financial objectives of marketing functions in an organization, marketing investment and management. Financial analysis of decisions involving product service expansion, contraction and substitution, product service development, credit sales analysis, analysis for pricing decisions, financial aspects of promotion, sales force management and other marketing operations.

**Mgt.-620 System Analysis** **2+0** **Sem. II**

An overview of systems types, purposive systems, man-made systems, cybernetics and systems models, control and analysis of hierarchical systems, adaptive systems and learning models. Control theory of social and economic systems, mathematical models, decision frame work for systems evaluation, criteria for evaluating public planning programme and budgeting systems

**Mgt.-621 Project Management with PERT and CPM** **2+0** **Sem. II**

Developing project network, time estimates and their distributions, basic scheduling computations, variations of basic scheduling computations, scheduling activities to satisfy resource constraints, time-cost trade-off procedures. An introduction to network cost control. PERT-statistical approach, critical path methods.

**Mgt.-622 Inventory Management** **2+0** **Sem. I**

Various types of inventory systems, maintaining smooth supply of raw-materials and finished products for production and marketing. Structure of optimal inventory policies, deterministic and stochastic models. Planning horizon theorem, parametric production planning, stochastic ordering, single critical level policies, myopia policies, Bayesian models, dependence of optimum policies in various parameters.

**Mgt.-623 Advanced Organisational Psychology** **2+0** **Sem. I**

Introduction to organisational psychology, Research methods and statistics is study of organizational psychology. Productive behaviour in organisations, Job satisfaction and organisational commitment. Occupational stress- approaches and terminology, occupational stress models, workplace stressors, reducing impact of workplace stressors. Theories of motivation and application in modern times. Leadership and influence processes- Modern theories of leadership. Introduction to group behaviour-stages of group development, the impact of groups on individuals. Group effectiveness, Intergroup behaviour in organizations. Organisational culture- models of organizational culture.

**Mgt.-624 Organisational Development** **2+0** **Sem. II**

Organisational development: concept, values, assumptions and beliefs. Foundations of organisational development - models and theories of planned change, organisational development process and action research. Organisational development interventions - team interventions, team formation and work groups, formal group team building meeting, process consultation, gestalt approach to team building, intergroup and third-party peace-making interventions, comprehensive interventions, organisations minor interventions, partnering and structural interventions. Sociotechnical system, self-managed teams, MBO, parallel learning structure. Issues in consultant - client relationships. Power and politics. Fundamental strengths and future of organisational development.

**Mgt.-625 International Human Resource Management** **2+0** **Sem. I**

International human resource management- concept, importance and approaches. Difference between domestic and international HRM, international HR activities, International human resource planning, global staffing practices, recruitment and selection for international assignments. International HR training and development- designing of training for overseas assignment. International HR compensation system

- objectives, factors affecting international compensation system, approaches, handling international taxation and designing a competitive expatriate compensation package. Multinational performance management, management of expatriates, expatriate re-entry.

**Mgt.-626 Advances in Business Ethics** **2+0** **Sem. I**

Business ethics – an overview, concepts and theories. Ethical dilemmas- sources and their resolution. Ethical decision making in business. Globalization and business ethics. Creating a modern ethical organization. Corporate ethics- good governance, investor rights, privileges, problems and protection. Corporate social responsibility, Ethics of consumer protection. Environmental ethics. Role of various agencies in ensuring ethics in modern business. Ethics and International business. Ethical Issues in human resource management.

**Mgt.-691 Seminar I** **1+0** **Sem. I**

**Mgt.-692 Seminar II** **1+0** **Sem. II**

**Mgt.-699 Ph.D Research** **0+75**

# AGRI-BUSINESS MANAGEMENT

## Undergraduate Courses

**ABM 201 Food Business Management** **2+0** **Sem. II**

Introduction to food, food business and food business management, Food Business. Present status of food industry in India. Current market size and future potential Key drivers for growth. Recent advances in food processing, Quality management in food industry- Food Safety and standards (ISO and Codex). Food traceability. Food Packaging and Labelling. Logistics management at different stages of marketing the food products. Food business environment and policy. IPR in Food Industry, Entrepreneurship opportunities in food business. Innovation in food business at domestic and International, Food Business Marketing. Food business Government, Regulations/Guidelines for food sector. Institutions enabling food processing sector, Food Safety and Standards Authority of India.

**ABM 202 Value Chain and Retail Management in Agribusiness** **2+1** **Sem. II**

Meaning of value and value chain. Concept of value chain. Difference between supply chain and value chain. Components of value chain. Financing of agricultural chain. Market linkages in value chain. Porters value chain. Introduction to Retail Management. Retailing in India. Types of retailers. Retail formats. Online and offline retailing. Organized and unorganized retailing. Retail location and layout. Retail strategies. Store management. Merchandise and inventory management. Retail marketing mix, role of IT in retail management. Etailing.

**Practical** : Case study presentation and Discussion on above topics. Visit of retail formats. Visit to processing units, logistic, godowns, warehouses etc.

**ABM 203 Introduction to Commodity Markets** **2+1** **Sem. II**

History and evolution of commodity markets. Marketing of food grains cereals and pulses, production, consumption, marketable surplus. Marketing of commercial crops: tea, cotton, oilseeds, spices, supply and demand. Marketing practices, market structure, marketing channels and price spread organizations and institutions, Commodity Boards and their activities. Marketing of horticultural crops Fruits, vegetables and flowers - demand, supply and utilization, marketing practices, NHB, NHM, APEDA. Role of commodity exchanges- difference between national and regional exchanges. Meaning and types of market participants Hedgers, Speculators, Arbitragers. Derivatives market meaning, functions and limitations. Types of derivatives - options, forward, futures. Factors influencing spot and futures markets. Trading strategies. Pricing of futures. Operational mechanism of commodity markets. Settlement process and delivery mechanisms. Strategies using options to hedge risks, long and short positions. Role of banks and warehousing in commodity markets

**Practical** : Compilation of basic statistics an area, production, productivity, consumption, export and import of selected crops. Estimating growth. Visit to Grain Market, Futures pay-offs calculation. Pricing of derivatives.

**ABM 301 Agri-input Marketing Management** **1+1** **Sem. I**

Agricultural input marketing -meaning and importance; Agricultural Inputs and their types -farm and non-farm, role of cooperative, public and private sectors in agri input marketing. Seed Marketing: Importance, Types of seeds, Demand and supply of seeds; agencies involved in Seed marketing, distribution, export import of seeds; Role of NSC and State Seed Corporation. Government policy on seed marketing. Fertilizer Marketing: Production, export-import, supply of chemical fertilizers. Demand /consumption, regional disparity in consumption, pricing policy; subsidy on fertilizers; marketing system - marketing channels, Agencies involved in fertilizer marketing- Public, Private, Co-operative sectors. Problems in distribution. Plant Protection Chemicals: Plant Protection Chemicals- Production, export/import, consumption, marketing channels. Electricity/Diesel Oil- distribution, pricing of electricity for agriculture use; subsidy on electricity. Farm Machinery and Implement: Production, supply, demand, distribution

channels of farm machines; Agencies involved in distribution of agro- machineries and implements. Meaning and importance of Land reforms and tenancy in agriculture, ceiling, elasticity, pricing. Labor markets productivity, heterogeneity, wage differentials-skill differentials. Credit: importance, types and sources. IT applications in agri- input marketing.

**Practical :** Input Market Analysis, Primary and Secondary Survey of input use, Exercise on Market Segmentation, Case Study on Product Management, Channel Management in Agri input, Case Study on Brand Management, Designing Communication and Promotion Measures -Seed, Designing Communication and Promotion Measures -Fertilizer, Designing Communication and Promotion Measures Plant Protection Chemicals, Designing Communication and Promotion Measures Agricultural Machinery and Implements, Market Research -Seed, Market Research -Fertilizers, Market Research-Plant Protection Chemicals, Market Research Farm Machinery and Implements, Formulation of Marketing Strategy Report Presentations.

**ABM 302 Rural Marketing Management** **2+1** **Sem. II**

Nature and Scope of Rural Marketing, Definition and Scope of Rural Marketing. Rural Market in India Size and Scope. Problems of Rural Market. Constraints in Rural Marketing and Strategies to Overcome Constraints. Rural Consumer vs. Urban Consumers-A Comparison, Characteristics of Rural Consumers. Rural Market Environment:(a) Demographics Population, Occupation Pattern, Literacy Level(b) Economic Factors -Income Generation, Expenditure Pattern, Rural Demand and Consumption Pattern, Rural Market Index, Land Use Pattern;(c) Rural Infrastructure –Rural godowns/warehousing, Electrification, Roads. Consumer behaviour: meaning and importance, Rural Consumer Behavior: Meaning, Factors Affecting Rural Consumer Behaviors-Social Factors, Cultural Factors, Technological Factors, Lifestyle, Personality. Rural marketing strategies: Relevance of Marketing Mix for Rural Market/Consumers. Product Strategies- Rural Product Categories-FMCGs, Consumer Durables, Agriculture Goods and Services; Importance of Branding, Packaging and Labeling. Nature of Competition in Rural Markets, the Problem of Fake Brands. Rural market segmentation –occupational segmentation. Sociological segmentation, Thomson rural Market Index, MICA rural marketing ratings and Lin Quest Data. Pricing Strategies and Objectives, pricing policies-innovative pricing methods for rural markets. Promotional Strategies. Segmentation, Targeting and Positioning for Rural Markets. Distribution Strategies for Rural Consumers: Channels of Distribution HAATS, Mandis, Public Distribution System, Co-operative Society, Distribution Models of FMCG, Model for Rural Markets. (Case Study Based). Communication Strategy: Challenges in Rural Communication, Developing Effective Communication, Determining Communication Objectives, Designing the Message, Selecting the Communication Channels. Creating Advertisements for Rural Audiences. Rural Media-Mass media, Nonconventional Media, Personalized Media. Innovative Distribution Channels like ITCE-choupal, Godrej Adhar, HUL Shakti. Rural Retail Markets: Understanding the rural retail environment, Emergence of modern retail markets in rural areas. Principles of Innovation for Rural Market Need for Innovation in Rural Market, Role of Government & NGOs in Rural Marketing.

**Practical :** Studying rural marketing environment, Rural marketing Research Process of Research in Rural Markets, Sources and Methods of Data Collection, Data Collection Approaches in Rural Markets. Corporate Sector in rural marketing, Rural Specific Promotion Media and Methods. Field visits or case studies: Understanding the Rural Market-A Practical Approach Case Studies.

**ABM 303 Agribusiness Project Management** **2+1** **Sem. II**

Meaning and definition of project, general features of projects, importance and objectives of project analysis. Categories of projects based on various criteria. Project cycle, stages of project cycle - conception, formulation, appraisal, implementation, monitoring and evaluation. Project formulation-market and demand feasibility, Technical feasibility, financial feasibility and ecological feasibility. Costs and benefits of agribusiness projects, comparing costs and benefits of agribusiness projects. Social cost benefit analysis and rationale for SCBA. Externalities - meaning and definition, positive externalities, negative externalities and internalization of externalities, divergence between social costs and benefits of a project. Criteria for appraising projects-Undiscounted measures of project worth - Accounting Rate of Return (ARR), ranking by inspection, payback period, proceeds per rupee of outlay and average annual proceeds per rupee of outlay. Time value of money - compounding and discounting, choice of discount rate. Discounted cash flow measures of project appraisal - Net Present Worth (NPW), Benefit-

Cost Ratio (BCR) and Internal Rate of Return (IRR). Risk and uncertainty. Sensitivity analysis, general kinds of sensitivity analyses, Project management - meaning, importance and triple constraint. Project management structures - functional organization, project organization and matrix organization - meaning, advantages and disadvantages. Project Rating Index (PRI), Work Breakdown Structure (WBS), Network analysis-CPM and PERT. Project financing - sources of financing a project. Business incubators - definition, types and their benefits. Project control - monitoring time performance (Gantt Charts, Control Charts), performance index and per cent complete index. Project audit and project closure.

**Practical :** Generation of agribusiness project ideas, project proposals in agribusiness sector (private and public), exercises on feasibility studies and formulation of detailed project proposals. Investment analysis - undiscounted measures and discounted measures of project worth. Review of case studies pertaining to management of agribusiness project.

**ABM 404 Agribusiness Student Project** **0+10** **Sem. I**

**Practical:** The students have to undertake a project work on organizational/ managerial/ institutional/ operational aspects related to Agri-business enterprises, Co-operative enterprises, financial and agri-marketing institutions and other related areas. The Project Work has the definite objectives: To equip the students to identify and analyze the organizational, managerial and operational problems of various organizations involved in socio-economic development activities; To train the students in the collection, classification, tabulation, analysis, presentation and interpretation of data and; To assist the students to acquire the report writing skills.

The first two weeks, review of relevant literatures and identify the topic for project work in consultation with the project guide/teacher. Then the student shall make a presentation of the project proposal before an Evaluation Committee for approval. The presentation has to cover the statement of the problem, objectives, sampling design, techniques of data collection and analysis. After the project work is over the student has to submit the project report in the prescribed format. The committee constituted for the purpose will evaluate the work.

**ABM 405 Entrepreneurial Development Programme** **0+2** **Sem. II**

**ABM 406 Preparation of Business Plan** **0+4** **Sem. II**

**Practical :** The students will prepare business plans for Agriculture and rural development businesses for Co-operatives/SHGs/Farmer Producer Companies/Local Self-governments/ State level Institutions /startups/other existing enterprises. The activities will encompass business environment scanning, assessment of financial, technical, social, environmental and economic sustainability and feasibility of the business plan, Network analysis and reporting in the standard format to suit the funding agencies.

**ABM 407 Industrial attachment** **0+10** **Sem. II**

Internship / Industrial attachment in Agribusiness and allied enterprises /Regulated markets/Commodity Boards /Organized Retail Markets/Commercial Banks/ Regional Rural Banks/Co-operatives/ Producer Companies. Report Writing and Evaluation.

## Postgraduate Courses

**ABM-501 Principles of Management and Organizational Behaviour** **3+0** **Sem. I**

**Unit I** Introduction to Management: Nature, Scope and Significance of Management, Evolution of Management Thought, Approaches to Management, functions and skills of a manager.

**Unit II** Management functions: Planning - Types, Steps, Objective, Process, Strategies, Policies, MBO, and Organizing – Structure & Process, Line, Staff, Authority & Responsibility, Staffing – Recruitment and Selection, Directing – Training, Communication & Motivation, Controlling- Significance, Process, Techniques, Standards & Benchmarks, and Management Audit.

**Unit III** Nature, Scope and Significance of Organizational Behaviour, Foundations of Individual behaviour – Emotions, Personality, Values, Attitudes, Perception, Learning and individual decision making, Motivation- Types of motivation, theories of motivation, motivational practices at workplace, managing stress and work life balance.

**Unit IV** Group dynamics- types of groups, group formation, Group decision making, team building and developing collaboration, leadership styles and influence process; leadership theories, leadership styles and effective leader.

**Unit V** Understanding and managing organisational culture, power and political behaviour in organisations, conflict Management, negotiation, managing organizational change, concept of organisational development.

**ABM-502 Managerial Accounting and Control** **2+1** **Sem. I**

**Unit I** Financial Accounting- Meaning, Need, Accounting principles: Accounting Concepts and Conventions; Branches of Accounting, Users of Accounting information, Advantages and Limitations of Financial Accounting, Accounting Standards.

**Unit II** The Double Entry System- Its Meaning and Scope, The Journal, Cash Book, Ledger, Trial Balance, Trading Account Profit and Loss Account, Balance Sheet, entries and adjustments of different heads in different Books and Accounts, Introduction of Company Accounts, Use of Accounting Software.

**Unit III** Management Accounting-Meaning, Functions, Scope, Utility, Limitations and Tools of Management Accounting, Analysis of Financial Statements- Ratio, time series, common size and Du pont Analysis, Comparative and Common Size Statements, Cash Flow and Fund Flow Analysis.

**Unit IV** Cost Accounting–Nature, Course, Significance of Cost Accounting; Classification of Cost, Costing for Material Labor and overheads; Marginal Costing and cost volume profit Analysis- Its Significance, Uses and Limitations; Standard Costing – Its Meaning, Uses and Limitations, Determination of Standard Cost, Variance Analysis-Material, Labor and Overhead.

**Unit V** Budget and Budgetary Control- Meaning, Uses and Limitations, Budgeting and Profit planning, Different Types of Budgets and their Preparations: Sales Budget, Purchase Budget, Production Budget, Cash Budget, Flexible Budget, Master Budget, Zero Based Budgeting. Mergers and Acquisition, Tax System- GST.

**Practical :** Numerical, Case Studies.

**ABM-503 Applied Agribusiness Economics** **2+0** **Sem. I**

**Unit I** Scope of managerial economics, objective of the firm and basic economic principles; mathematical concepts used in managerial economics. Introduction to behavioral economics.

**Unit II** Indifference curves and budget sets - Demand analysis - meaning, types and determinants of demand; demand function; demand elasticity; demand forecasting-need and techniques.

**Unit III** Production, cost and supply analysis- production function, Multi period production and cost least-cost input combination, factor productivities and returns to scale, cost concepts, cost output relationship, short and long-run supply functions.

**Unit IV** Pricing-determinants of price - pricing under different market structures, pricing of joint products, pricing methods in practice, government policies and pricing. Price discrimination (First, Second and Third level).

**Unit V** The national income; circular flow of income: consumption, investment and saving: money-functions, factors influencing demand for money & supply of money; inflation; economic growth; business cycles and business policies; business decisions under certain and uncertain situations.

**ABM-504 Human Resource Management for Agricultural Organizations** **2+0** **Sem. II**

**Unit I** Strategic Human Resource Management, Human Resource Planning-Nature and Significance, Job Analysis and talent management process, Job Description, job Specification, Job enlargement, Job enrichment, Job rotation.

**Unit II** Recruitment and Selection Process, Induction, Training and Human Resource Development-Nature, Significance, Process and Techniques, e- recruitment, use of Big Data for recruitment, use of Artificial Intelligence and machine learning tools in recruitment practices Career planning and Development Internal mobility including Transfers, Promotions, employee separation.

**Unit III** Performance Appraisal–Significance and methods, Compensation management, Strategic pay plans, Job Evaluation, Wage and Salary Administration; Wage Fixation; Fringe Benefits, Incentive Payment, bonus, and Profit Sharing.

**Unit IV** Role and Status of Trade Unions; Collective Bargaining; Worker's Participation in Management, employee retention. Quality of work life, employee welfare measure, work life balance, Disputes and Grievance Handling Procedures; Arbitration and Adjudication; Health and Safety of Human Resources.

**Unit V** Ethical issues in HRM, Managing Global Human Resources, Managing Human Resources in Small and Entrepreneurial firms, Human Resources accounting, Human Resources outsourcing. HR Information System, Human Resource Metrics and Workforce Analytics, Future trends in workforce technologies.

**ABM-505 Production and Operations Management 2+0 Sem. II**

**Unit I** Nature Concept and Scope of Production and Operations Management; Factors Affecting System; Facility location, Types of Manufacturing Systems and Layouts, Process Selection and Facility Layout, Layout Planning and Analysis, Forecasting.

**Unit II** Operations Strategy: Operations Strategy, Competitive Capabilities and Core Competencies, Operations Strategy as a Competitive Weapon, Linkage between Corporate, Business, and Operations Strategy, Developing Operations Strategy, Elements or Components of Operations Strategy, Competitive Priorities, Manufacturing Strategies, Service Strategies, Global Strategies and Role of Operations Strategy.

**Unit III** Productivity Variables and Productivity Measurement, Production Planning and Control, Mass Production, Batch Production, Job Order Manufacturing, Product Selection, Product Design and Development, Process Selection, Capacity planning.

**Unit IV** An Overview of Inventory Management Fundamentals, Determination of Material Requirement, Safety Management Scheduling, Maintenance Management Concepts, Work Study, Method Study, Work Measurement, Work Sampling, Work Environment, Production Planning and Control (PPC) Industrial Safety, human-machine interface, types of interface designs. Cloud operations management.

**Unit V** Quality Assurance, Accepting Sampling, Statistical Process Control, Total Quality Management, ISO standards and their Importance, Introduction to re-engineering, value engineering, check sheets, Pareto charts, Ishikawa charts, JIT Pre-requisites for implementation Six Sigma, Lean Management, Reliability Engineering, Safety Engineering, Fault Tree Analysis.

**ABM-506 Agricultural and Food Marketing Management- I 2+0 Sem. I**

**Unit I** Introduction and Concept/ philosophies of Marketing Management; Product Management: The product, The product mix, Product line extensions, Product line deletions, Branding products, The advantages and disadvantages of branding, Branding decisions Brand loyalty models, Homogenous first-order Markov models, Higher-order Markov models Packaging, The functions of packaging, Packaging technology, Recent developments in packaging

**Unit II** Pricing objectives, the laws of supply and demand, Elasticity of demand Cross-price elasticity of demand, Practical problems of price theory, Cost - revenue - supply relationships, The meaning of price to consumers, Price as an indicator of quality, Pricing strategies, Cost-plus methods of price determination, Breakeven analysis, Market-oriented pricing, Psychological pricing, Geographical pricing, Administered pricing.

**Unit III** Channel decisions in relation to marketing strategy, The value of middlemen, Key decisions in channel management, Types of distribution system, Marketing to middlemen, Power and conflict in distribution channels, Physical distribution, Customer service levels, Developing a customer service policy, The total distribution concept, Warehouse management, Inventory management, Calculating the economic order quantity, Transport management, Technological advances in physical distribution, Vehicle scheduling and routing, Fixed and variable routing systems, Vehicle scheduling tools, Vehicle scheduling models, Computer-based vehicle scheduling.

**Unit IV** The nature of marketing communications, Setting marketing communication objectives, Factors influencing the communications mix, the marketing communications mix, Advertising, Sales promotion, Public relations, Personal selling, Digital Marketing, Mobile Marketing, Social Marketing and Social Media Marketing, Training the sales force, Change agents, Selecting the media, Establishing the promotional budget, Monitoring the effectiveness of marketing communications.

**Unit V** Marketing Costs and Margins: Assessing the performance of a marketing system, Marketing efficiency and effectiveness, Operational efficiency, Pricing efficiency, Identifying marketing costs and margins, The reference products concept, Handling costs, Packaging costs, Transport costs, Storage costs, Processing costs, Capital costs.

**ABM-507 Agricultural and Food Marketing Management- II 2+0 Sem. II**

**Unit I** The importance of agricultural and food marketing to developing countries, the marketing concept and marketing systems, Marketing sub-systems Marketing functions, Links between agriculture and the food industry, Agricultural and food marketing enterprises, Marketing boards in developing countries, Co-operatives in the agriculture and food sectors, Control and management of secondary co-operatives, The weaknesses of co- operatives, Selling arrangements between co-operatives and their members.

**Unit II** Market Liberalization: Economic structural adjustment programmes, Macro- economic stabilization, The role of the state in liberalized markets, Strategies for reforming agricultural marketing, Obstacles to be overcome in commercialization and Privatization of agricultural marketing, Dealing with accumulated deficits, Encouraging private sector involvement in agricultural marketing, Impediments to private sector participation in agricultural markets, impact of the macro-economic environment on private traders, Government action to improve private sector performance.

**Unit III** Marketing Strategy, Planning and Control: Strategy, policy and planning, Strategic business units, The need for marketing planning, The process of marketing planning, Contents of the marketing plan, Monitoring, evaluating and controlling the marketing planning, Marketing controls, Marketing plan control, Efficiency control.

**Unit IV** New Product Development: The impetus to innovation, New product development process The adoption process, The effect of products characteristics on the rate of adoption, Buyer behavior: The influences on buyer behavior, Exogenous influences on buyer behavior Endogenous influences on buyer behavior, The consumer buying decision process, Buyer behavior and market segmentation, Lifestyle segmentation, Organizational markets Industrial markets, Industrial buyer characteristics.

**Unit V** Stages in a commodity marketing system, Grain marketing, Challenges for grain marketing systems, fruits and vegetables, Livestock and meat marketing, Poultry and eggs marketing, marketing of fresh milk.

**ABM-508 Agri Supply Chain Management 2+0 Sem. I**

**Unit I** Supply Chain: Changing Business Environment; SCM: Present Need; Conceptual Model of Supply Chain Management; Evolution of SCM; SCM Approach; Traditional Agri. Supply Chain Management Approach; Modern Supply Chain Management Approach; Elements in SCM. Innovations in Global Agri-SCM.

**Unit II** Demand Management in Supply Chain: Types of Demand, Demand Planning and Forecasting; Operations Management in Supply Chain, Basic Principles of Manufacturing Management. SCM Metrics/ Drivers and Obstacles.

**Unit III** Purchasing Cycle, Types of Purchases, Contract/Corporate Farming, Classification of Purchases Goods or Services, Traditional Inventory Management, Material Requirements Planning, Just in Time (JIT), Vendor Managed Inventory (VMI).

**Unit IV** History and Evolution of Logistics; Elements of Logistics; Management; Distribution Management, Distribution Strategies; Pool Distribution; Transportation Management; Fleet Management; Service Innovation; Warehousing; Packaging for Logistics, Third-Party Logistics (TPL/3PL); GPS Technology.

**Unit V** Concept of Information Technology: IT Application in SCM; Advanced Planning and Scheduling; SCM in Electronic Business; Role of Knowledge in SCM; Performance Measurement and Controls in Agri. Supply Chain Management- Benchmarking: introduction, concept and forms of Benchmarking. Case Studies on the following:(a) Green Supply Chains (b) Global Supply Chains (c) Coordination in a SC. Value of and distortion of information: Bullwhip effect (d) Sourcing and contracts in SC (e) Product availability with uncertain demand (f) Inventory planning with known /unknown demand (g) Cases from FAO/IFPRI etc.

**ABM-509 International Trade for Agricultural Products** **2+0** **Sem. II**

**Unit I** International trade–basic concepts, WTO and its implications for Indian economy in general and agriculture sector in particular.

**Unit II** TRIMS quotas, anti-dumping duties, quantitative and qualitative restrictions, tariff and non-tariff measures, trade liberalization, subsidies, green and red boxes, issues for negotiations in future in WTO; CDMs and carbon trade.

**Unit III** Importance of foreign trade for developing economy; absolute and comparative advantage, foreign trade of India. Cases on agri business commodity trade practices.

**Unit IV** India's balance of payments; inter regional vs. international trade; tariffs and trade control; exchange rate; the foreign trade multiplier.

**Unit V** Foreign demand, supply side analysis, opportunity cost, trade and factor prices, implications for developing countries, market entry methods, export procedures & documentations.

**ABM-510 Food Technology and Processing Management** **3+0** **Sem. I**

**Unit I** Food Industry in India: Present status of food industry in India; Organization in food industry; Introduction to operations of food industry; Deteriorative factors and hazards during processing, storage, handling and distribution.

**Unit II** Basics of Food Processing: Basic principles of food processing and food preservation through technology interventions; Application of energy, radiations, chemicals and other agents for food preservation; aseptic modes of processing-freezing, quick, cryogenic, high pressure, membrane technology; Packaging of foods, labelling techniques, advanced technologies for packaging.

**Unit III** Food Safety and Costs Analysis: Analysis of costs; risk management; Laws and regulations w.r.t to food industry including production, processing and marketing; Food Safety and Quality Standards-AGMARK; BIS/ISO; FPO,FSSAI .TQM, HACCP etc.

**Unit IV** Case studies on project formulation in various types of food industries: Discussion sessions and analysis of Case studies related to dairy, cereal milling, sugarcane production; baking/confectionary, vegetable storage, handling, egg processing, fish and meat products; Cases related HACCP.

**ABM-511 Rural Marketing** **3+0** **Sem. II**

**Unit I** Rural Market Concept & Scope: Concept, Definition and Scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India, rural V/S urban market.

**Unit II** Environmental factors: Socio-cultural, economic, demographic, technological and other environmental factors affecting rural marketing.

**Unit III** Rural finance: Concept, demand, banking model; Finance Schemes of NABARD, Other Schemes of State Govt, Central.

**Unit IV** Rural consumer's behavior: Behavior of rural consumers and farmers; buyer characteristics and buying behavior; customer relationship management, rural market research.

**Unit V** Rural Product strategy: Marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning; marketing mix, product mix.

**Unit VI** Pricing for rural markets: Pricing policy and pricing strategy, distribution strategy, rural retailing and modern store formats in rural areas.

**Unit VII** Promotion and communication strategy: Media Planning, Distribution channels, personal selling strategies in rural markets, innovations in rural marketing.

**ABM-512 Fertilizer Technology and Management** **3+0** **Sem. I**

**Unit I** Fertilizer development: Concept, scope, need, resource availability; import and export avenues for fertilizer; types of fertilizers, grading and chemical constituents, role of fertilizers in agricultural production, production and consumption of fertilizer in India.

**Unit II** Raw material Supply; Principles of manufacturing-potassic fertilizers, secondary and micro-nutrient formulations.

**Unit III** Production efficiency: Production efficiency and capacity utilization; quality control and legal aspects fertilizer control order.

**Unit IV** Testing facilities; constraints in fertilizer use; assessment of demand and supply of different fertilizers, fertilizer distribution, and fertilizer storage.

**Unit V** Field trials and demonstrations; environmental pollution due to fertilizers.

**ABM-513 Management of Agro-Chemical Industry** **3+0** **Sem. I**

**Unit I** Introduction: Agro-chemicals: Definition and classification; Basic knowledge of agro- chemicals; role and status of agro-chemical industry in India; Pesticides – Classification and Introduction, knowledge of different pesticides

**Unit II** Insecticides: Insecticides – Definition and classification based on (a) Mode of Entry (b) Mode of Action and(c) Chemical Structure with example; Insecticidal formulation; preliminary knowledge of mode of action of insecticides; knowledge of plant protection equipment's.

**Unit III** Fungicides: Fungicides – Classification and preliminary knowledge of commonly used fungicides; Bio magnifications of pesticides and pesticidal pollution.

**Unit IV** Insecticide Act: Introductory knowledge about development of agro- chemicals; Insecticidal poisoning, symptoms and treatment; Main features of Insecticide Act.

**Unit V** Plant Protection: Directorate of Plant Protection, Quarantine and Storage– A brief account of its organizational set up and functions; IPM Concept – Bio- pesticides – Plant products**.**

**ABM-514 Seed Production Technology Management** **3+0** **Sem. I**

**Unit I** Seed Technology: Role of Seed Technology, its Course Objective and goal, Seed Industry in India, National Seed Corporation – Tarai Seed Development, Corporation, State Seed Corporations, National Seed Project and State Farms and their role

**Unit II** Development and Management of Seed Programme: Seed Village Concept, Basic Strategy of Seed Production and Planning and Organization of Seed Programme; Types of Seed Programme – Nucleus seed, Breeders seed, Foundation seed and Certified seed etc.

**Unit III** Maintenance of genetic purity: Minimum seed certification standard and Management of breeders & Nucleus seed; Management of seed testing laboratory and research and development.

**Unit IV** Management of seed processing plant seed storage management; seed packaging and handling.

**Unit V** Seed Marketing: GM Crop seed, IPR, PBR, Patents and related issues and their impact on developing countries; Statutory intervention in the seed industry; Seed legislation and seed law enforcement, Seed act; Orientation and visit to seed production farms, seed processing Units, NSC, RSSC, RSSCA and seed testing laboratories.

**ABM-515 Technology Management for Livestock products** **3+0** **Sem. II**

**Unit I** Present status of livestock products industry in India: Dairy, meat, skin and hides, wool, etc.;

SWOT analysis of livestock product industry, importance of value addition of livestock products, Concept of organic milk and meat. New techniques of biotechnology for improving food value.

**Unit II** Manufacturing technologies: Dairy-Manufacturing technologies of various dairy products and by product utilization. Meat- Manufacturing technologies of meat and its products, industrial processing and utilization of wool and animal by-products, value added egg product development**.**

**Unit III** Milk and meat processing plant: Layout and designing of milk and meat processing plant, abattoir design, sanitation and basic slaughterhouse practices, Plant Management- Production, planning and control, packaging, preservation and storage system for livestock products; transportation system for domestic markets and international markets.

**Unit IV** Total quality management in processing Total quality management in processing of milk and its by product, meat and by product, value added egg duct and wool, Quality control measures during storage transit; extent of losses during storage and transport, management measures to minimize the loss.

**Unit V** Marketing livestock products - Milk, meat, wool, fish etc. and its by product, Marketing and distribution system of animal products; National and international specifications and quality standards for various products; environmental and legal issues involved.

**ABM-516 Fruit Production and Post Harvest Management 3+0 Sem. II**

**Unit I** Introduction: Global and National Status of Horticultural production in India and emerging scenario.

**Unit II** Management of horticultural crops: Establishing an orchard, basic cultural practices, regulation of flowering, fruiting and thinning, protection against insect- pest, weeds: Maturity indices, Harvesting and its relationship with quality, sorting and grading, pre-harvest crop management practices and their influence on quality during storage and marketing.

**Unit III** Post harvest management in horticulture-procurement: Procurement management, important factors for marketing, standardization and quality control, packaging. Physiology of ripening and senescence. Storage system: on-farm storage-evaporative cooled stores, ventilated storage, pit storage etc. Refrigerated storage refrigeration cycle, controlled/modified atmosphere, hypobaric storage.

**Unit IV** Post harvest management in horticulture process: Application of growth regulators for quality assurance, post-harvest treatments: pre cooling, heat treatments (hot water, hot air and vapor heat), fungicides & biologically safe chemicals, irradiation, curing, pulsing etc. Packing line operations, packaging of horticultural produce. Transportation rail, road, sea, air. Codex norms for export of perishables. Development of fruit-based carbonated drinks, development of dehydrated products from some important fruits, storage of pulp in pouches, essential oils from fruit waste, dehydrated fruits. Market structure and export potential of fruits.

**Unit V** Marketing of fruits: Problems in marketing of fruits, and government policy; quality standards for domestic and international trade.

**ABM-517 Farm Power and Machinery Management 2+0 Sem. I**

**Unit I** Farm power and tractors: Farm power in India - sources, IC engines – working principles, two stoke and four stoke engines, IC engine terminology, different systems of IC engine. Tractors – types and utilities.

**Unit II** Tillage and Tillage machinery: Tillage – ploughing methods – primary tillage implements – mould board, disc plough and chisel plough – secondary tillage implements – cultivators, harrows and rotovators – wetland equipment – puddlers, tramplers and cage wheels**.**

**Unit III** Sowing, Planting and Intercultural Equipment: Sowing methods – seed drills, seed cum fertilizer drills – Paddy transplanters – nursery requirements – implements for intercultural operations – wet land, dry land and garden land intercultural tools. Plant Protection Gadgets, Harvesting Machinery and Horticulture tools: Plant protection equipment, tools for horticultural crops.

**Unit IV** Agricultural equipment's industry: Agricultural equipment's production, marketing and constraints; establishment of agricultural engineering enterprises (agro service centers, etc.). Equipment

for land development and farm machinery selection: Equipment for land development and soil conservation.

**Unit V** Cost analysis of operations: Cost analysis of operations using different implements, economic performance of machines, and optimization of tractor implements system and transport of farm produce. Cost of operation of farm machinery – Tractor and implement selection.

**ABM-518 Food Retail Management** **2+0** **Sem. I**

**Unit I** Introduction to Food market: Introduction to International Food market, India's Competitive Position in World Food Trade, Foreign Investment in Global Food Industry, Retail management and Food Retailing, The Nature of Change in Retailing, Organized Retailing in India, E-tailing and Understanding food preference of Indian Consumer, Food consumption and Expenditure pattern, Demographic and Psychographic factors affecting Food Pattern of Indian Consumer.

**Unit II** Value Chain in Food Retailing: Value chain and value additions across the chain in food retail, Principal trends in food wholesaling and retailing, Competition and pricing in food retailing, various retailing formats, the changing nature of food stores, market implications of new retail developments, food service marketing.

**Unit III** Marketing Mix in Food Retail Management: Merchandise Management, Pricing Strategies used in conventional and non-conventional food retailing, Public distribution system, Promotion mix for food retailing, Management of sales promotion and Publicity, Advertisement Strategies for food retailers & Brand Management in Retailing.

**Unit IV** Managing Retail Operations: Managing Retailers' Finances, Merchandise buying and handling, Logistics, procurement of Food products and Handling Transportation of Food Products.

**Unit V** Retail Sales Management: Types of Retail Selling, Salesperson selection, Salesperson training, Evaluation and Monitoring, Customer Relationship Management, Managing Human Resources in retailing, Legal and Ethical issues in Retailing.

**ABM-519 Management of Agricultural Input Marketing** **2+0** **Sem. I**

**Unit I** Market for agricultural inputs: Nature of demand, promotional media, and nature of competition, a framework for understanding the markets for inputs, agronomic potential, agro economic potential, effective demand, and actual consumption.

**Unit II** Marketing of seeds: Government policy, product, trade practices in seed production, seed pricing, input costs, distribution system, management of seed distribution. Proper storage of seeds, promotion, problems faced by seed industry, strategy for a seed enterprise, source of seeds, terms of transaction for seed procurements.

**Unit III** Marketing of fertilizers: Nature of Indian fertilizer market, product, fertilizer distribution, marketing cost and margins, credit, dealer selection and management, fertilizer promotion and extension, promotional program, advertising in fertilizers, emerging marketing mix in fertilizer, extension strategy for the future, marketing of bio fertilizers, strategies for fertilizer marketing

**Unit IV** Marketing of pesticides: Market profile, structure of industry, farmer behavior, problems of farmers in pesticide purchase and usage, marketing mix, bio pesticides market development and promotion activities, problems in marketing of bio pesticides. Integrated pest management.

**Unit V** Marketing of tractors: Segments in tractor market, market share, nature of demand, buyer behavior, role of distribution, promotion, MNC's. Marketing of credit-Nature of market, market segment, market players, marketing mix, and marketing options. Strategies for input marketing-Client and location specific promotion, joint promotion, interdependence of input markets, management of demands, developmental marketing, usp, extension services, ethics in business, sustainability.

**ABM-520 Feed Business Management** **2+0** **Sem. I**

**Unit I** Feed resources: Gap between demand and availability of nutrients; status of feed industry in India and world, constraints in the development of Indian feed industry.

**Unit II** Nutrients requirements of livestock and poultry: Knowledge about the quality of feed ingredients used in feed manufacturing. Procurement procedure of feed ingredients, scientific storage of feeds and feed ingredients. BIS, CLAFMA and all other commercial standards of all class of livestock and poultry feeds.

**Unit III** Feed preparation: Layout and design of feed plants, feed plant management; Basic principles of processing of feeds, Feed preparation for cattle and poultry and as specialty feeds for aqua and pet animals.

**Unit IV** Importance of mineral mixture: Feed additives, supplements and pass feed, to know the new technology regarding improving the feeding value of poor quality roughages. To acquaint the concept of silage technology, complete feed Block technology, hydroponics technology and UMMB technology.

**Unit V** Feed Distribution: Distribution channels, regulations relating to manufacture and sale of feed stuffs.

**ABM-521 Management of Veterinary Hospitals 2+0 Sem. I**

**Unit I** Needs, aims and objectives: Objectives of Veterinary hospitals; the existing and simulated situations under which veterinary hospitals work or are to work.

**Unit II** Designing and planning an ideal hospital: Optimizing the use of resources - human, space, equipment, drugs, time, capital, etc.; Materials management and problems Normal purchase procedure. Receipt; storage and distribution of materials Cost reduction & scientific inventory control. Information system and materials management performance. Equipment maintenance, condemnation & disposal.

**Unit III** Authority, responsibility: Accountability of management for optimizing the use of skill, developing and upgrading skills and technology; efficient system of record keeping and accounting; Concept of quality & Total quality management (T.Q.M) Introduction to Veterinary audit, Statistical quality control (S.Q.C.), Quality control Circle (Q.C.C.).

**Unit IV** Hospital information system: Hospital information system as an aid to efficient controlling and monitoring; need for financial resources - investment and working capital. Records: Types & Methodology, Reports and Reporting system. Contemporary and need-based methods of accounting; General consideration. Need based information system. Applicability in surveillance & monitoring; planning & policy making; cost control.

**Unit V** Quality control system: Economic functions and quality control system; Animal health Economics: An introduction Need for financial resources (type and need). Investment planning and working capital; Budgeting and cost cutting (cost control).legal aspects in the functioning of the hospital.

**ABM-522 Poultry and Hatchery Management 2+0 Sem. II**

**Unit I** Poultry and hatchery Business: Poultry and hatchery industry; Present scenario of Poultry industry, Integration in poultry farming, Scope and future perspective, role of management in poultry industry.

**Unit II** Poultry and hatchery unit: Planning and establishing a poultry and hatchery unit- location, size and construction; farm and hatchery equipment's and physical facilities; organizing and managing a poultry farm and hatchery.

**Unit III** Incubation and hatching Production of quality chicks and eggs; factors affecting hatchability; bio-security and hatchery sanitation; handling of hatching eggs; maintaining chick quality-chick grading, sexing, packing, dispatch, transportation and chick delivery.

**Unit IV** Franchise hatcheries management: Custom hatching; brooding; growing and laying management; crisis management; industrial breeding, feeding, housing and disease management; waste management; Record management; cost accounting and budgetary control**.**

**Unit V** Personal management and insurance: Labor relations including wages and salaries, job evaluation and employee appraisal; marketing management direct sale and sale through franchisees/ agents, advertisement, sale and after sale services, other innovative sales strategies.

**ABM-523 Management of Floriculture and Landscaping** **2+0 Sem. II**

**Unit I** Introduction: Introduction, importance and scope of floriculture industry and landscaping; Recent advances in floriculture industry.

**Unit II** Indoor and ornamental plants: Raising of foliage plants in pots, production technology of ornamental plants, commercial cultivation of flower crops (rose, jasmine gladiolus, tuberose, marigold, aster, carnation, gerbera, cilium chrysanthemum; special techniques for forcing of flowers for export.

**Unit III** Introduction: Drying and dehydration of flowers; bonsai; scope of landscaping, response of flowering plants to environmental stresses.

**Unit IV** Landscape gardening: Styles of gardening; modern and traditional garden planning; Socio-aesthetic planning; use of computers in designing gardens; planning towns.

**Unit V** Value Addition in floriculture: Extraction, purification and storage of essential oils and perfumes; post-harvest storage changes; packing techniques of produce harvesting of flowers for export and home use, Export-Import trade in flowers and their specifications along major trading countries.

**ABM-524 Risk Management in Agri-Business** **2+0 Sem. II**

**Unit I** Financial Intermediation, Indian Financial system, Origin and Growth of Banking. RBI and its functions. Principles of Banking, Banking Law and Practice. Nationalization of Banks in India, Deposit Products, Lending Activities, Retail Banking, Wealth Management, Financing SMEs, Corporate Banking, Forex Management, Fee-Based & Subsidiary Services, Plastic Money, Role of Central Banks, Emerging Trends in Banking, Fundamentals of International Banking.

**Unit II** Strategic Issues in Bank Marketing, Positioning Bank Services in the Market, New Product Development, Pricing and Launching, New Distribution Channels for Bank Marketing, Communicating and Promoting Bank Services, Improving Quality and Productivity, Customer. Relationship Management in Banks, Globalizing Bank Services, Opportunities and Challenges in Bank Marketing.

**Unit III** Credit Policy in Banks, Principles of Credit Management, Objectives of Credit Management, Credit Disbursal and Monitoring, Credit Deployment and Types of Borrowers, Follow up and Recovery Management, Treasury Operations, Introduction to Risk Management in Banks, Rural Banking in India, Security Considerations, Control System in Banks, Corporate Governance in Banks, Annual Reports and Statutory Audit.

**Unit IV** Introduction to Banking Operations, Front Office and Back Office Operations, Operational Controls, Demand Forecasting and Resource Allocation, Policy Framing – Deposits, Advances and Investments, Services Design and Delivery Strategies in Banks, Service Quality Metrics, Work Measurement and Quality Assurance, Payment and Settlement Systems, RTGS and Clearing House, Cash Management Services, Facilities Planning, ERP in Banks, BPR in Banks, IT Enabled Supply Chain Management, Disaster and Recovery Management.

**Unit V** Introduction to Risk, Risk Management Essentials, Measurement of Risk, Loss Exposure, Risk Management – Non-insurance Techniques, Introduction to Insurance, Principles of Insurance, Insurance Industry, Insurance Market, Insurance as Risk Management Techniques, Selection and Implementation of Risk Management Techniques.

**ABM-525 Management of Agri-Business Co-operatives** **2+0 Sem. II**

**Unit I** Cooperative administration: Global perspective, ecology of cooperative administration, cooperative sector and economic development.

**Unit II** Cooperative management: Nature, functions and purpose of cooperatives – procurement, storage, processing, marketing, process of cooperative formation, role of leadership in cooperative management.

**Unit III** Cooperative Movement: The state and cooperative movement, effects of cooperative law in management, long range planning for cooperative expansion, policy making.

**Unit IV** Human resource management: Placement and role of board of directors in cooperative management.

**Unit V** Overview of agribusiness cooperative: Credit cooperatives, cooperative marketing, dairy cooperative; financing agribusiness cooperative.

**ABM-526 Business Analytics for Agriculture** **1+1** **Sem. I**

**Unit I** Introduction to data science, evolution of data science, work profile of a data scientist, career in data science, nature of data science, typical working day of a data scientist, importance of data science in agribusiness; defining algorithm, big data, business analytics, statistical learning, defining machine learning, defining artificial intelligence, data mining; difference between analysis and analytics, business intelligence and business analytics, typical process of business analytics cycle.

**Unit II** Fundamental of Research -Fundamentals of R and R Studio, fundamentals of packages of R Studio, data manipulations, data transformations, normalization, standardization, missing values imputation, dummy variables, data visualization (2D and 3D), basic architecture of machine learning analytical cycle, descriptive analytics-case study covering data manipulation, measures of central tendency, measures of dispersion, measures of distribution, measures of associations, t-test, f test, ANOVA, Chi-square test, basic statistical modeling framework.

**Unit III** Supervised machine learning: Basic framework, regression models and classification models. Linear regression, nonlinear regression, multiple regression, polynomial regression, lasso regression, ridge regression, stepwise regression, quantile regression, logistic regression.

**Unit IV** Supervised machine learning: Linear discriminant analysis, principal component analysis, factor analysis, support vector machines, naïve Bayes, nearest neighbors, decision trees, random forest, ensemble methods, k-fold cross validation, X gradient boosting. Unsupervised machine learning—basic framework, concept of clustering, k-means, c-means, hierarchical clustering, hidden markov models, forecasting models (AR, MA, ARMA and ARIMA).

**Unit V** Deep learning: Basic framework of neural nets, types of neural nets, computer vision, object detection and localization, gradient descent optimization for loss function, regularization L1 and L2, feed forward neural nets, back propagation, recurrent neural nets, convolutional neural nets, reinforcement neural net, concurrent net, introduction to IoT. All the illustrations used in the syllabus of Data Science in Agribusiness will be primarily from agribusiness domains and R Studio will be used for practical purposes

**Practical :** Numerical, Case Studies.

**ABM-527 Dairy Business Management** **1+0** **Sem. I**

**Unit I** Dairy Development in India: Dairy organizations: functioning, Challenges and Opportunities, An and pattern dairy Cooperatives: features and impact; Public sector dairy schemes, Dairy Development schemes, Dairy problems and policies, National Dairy Plan-I, Rise of Producer Companies. Policy Frameworks in context to dairying.

**Unit II** Dairy Plant Management System: Production Planning and control in dairy plants, milk procurement from the rural milk producer, milk processing and products manufacturing. Pricing and marketing of milk and milk products. Survey on milk production potential and marketed surplus of milk for setting up of milk plants, energy utilization, Conventional and nonconventional sources of energy used in dairy sector. Concept of Quality; TQM concept and Kaizen in Dairy Industry, new concepts in quality assurance (HACCP; ISO certification); patent laws, pollution control laws in relation to dairy plants. Guidelines for obtaining ISO/HACCP certification for dairy plants. SQC in dairy operations.

**Unit III** Marketing Management, Supply Chain and International Trade in Dairy sector: Marketing- mix in relation to dairy sector, marketing environment, Marketing Opportunities Analysis in Milk and Milk Products: Demand status of Milk and milk products in the country, growth rates, Marketing research and marketing information systems; Market measurement present and future demand; Market forecasting. Market segmentation, Product-mix; Promotion mix decisions. Advertising; Sales Promotion. Food and Dairy Products Marketing, Consumer Buying Behavior; New product development process Price determination and pricing policy International Marketing Composition & direction of Indian exports Direct exports, indirect exports; WTO and its Implications; SPS/TBT; Supply chain Management in Dairy sector Logistics Management: Primary and Secondary Markets; Distribution channels; chilling points.

**Unit IV** Strategic, HR Management and Entrepreneurship in Dairy Sector: PESTLE analysis, BCG matrix, Strategic Management in dairy industry, Governance Structure in Dairy Sector, Management control System. Organizational Performance parameters – Quantitative and Financial, Use of Balanced Score card and other strategy control tools. HR management practices in dairy sector, Promotions, transfers employee remuneration and other HR benefits and problems. Motivation, turnover, employee capacity building, Training and orientation etc. social and business economics; industrial relations and human values; labor laws; trade unionism Business Plan Preparation; TIDP plant setting; Compliances Systems in Dairy Industry.

**Unit V** Financial Management and Financial Analysis in dairy sector: Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis. Sources of long term capital in dairy Industry: Grants from NDDB, Grants from NABARD, Government and Other Schemes, cost of debt, debentures, preference share capital, equity share capital & retained earnings, overall cost of capital. Capital budgeting in dairy Industry. Various techniques: NPV, IRR, etc. Financial Planning and control in dairy Industry: Budgeting process, Problems and practices in Budgeting and evaluation. Cost Volume – Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis. Costing in Dairy sector: Costing Techniques and Costing of various dairy products – Milk costing based on Fat and SNF, Ice cream, milk, Paneer, etc. Essentials of sound costing system. Different methods of costing, elements of cost: Labor- recording of time, idle time, methods of remunerating labor, Premium & Bonus Plans, Materials, Overheads.

**ABM-528 Agri Extension Management** **1+0** **Sem. I**

**Unit I** Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

**Unit II** Cyber Extension: Concept of cyber extension, national and international cases of extension projects using ICT and their impact of agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research - Extension -Farmer - Market linkage: Importance, Scope, Implications etc., Market – Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership. Stakeholder's analysis in Extension. Main streaming gender in Extension - Issues and Prospects

**Unit III** Implications of WTO: OA for extension services, re-orientation of extension services for agri-business and marketing activities, GOI- NGO collaboration to improve efficiency of extension.

**Unit IV** Extension and contemporary issues: Extension and issues related to rural poverty. Privatization of Extension. Intellectual Property Rights (IPRs). Extension Reforms in India – Decentralized decision making, Bottom up planning, Farming System and Situation based Extension Delivery System, Extension delivery through Commodity Interest Groups. Organization innovations in Extension - ATIC, IVLP, Kisan Call Centres.

**ABM-529 Renewable Energy Sources Management** **1+0** **Sem. I**

**Unit I** Introduction: Concept on alternate and non-conventional energy sources. Biofuels, Geothermal, Ocean, Hydropower, Biogas, Solar and Wind energy.

**Unit II** Commercial application: Commercial application of renewable energy sources and its benefits. Government Policy towards promoting renewable energy.

**Unit III** Institutional Framework: MNRE, CREDA-Renewable Energy Development Authority, State level Renewable Energy Development Agency, and Society of Renewable Energy.

**Unit IV** Devices for renewable energy development: Biogas plant, Wind Mills, Solar Cells – Solar Pumps, Solar Dryers, Solar water heating system etc.

**ABM-530 Quality Management for Agri-Business** **1+0** **Sem. I**

**Unit I** Basic concepts of quality management: importance of quality and the role of quality assurance in agribusiness.

**Unit II** Total Quality Management: TQM and business strategy. Quality control process and its relevance.

**Unit III** Quality grades and standards: Overview and relevance, benefits to consumers, producers and food processors, food grades and standards for various food commodities; cereals, fruits and vegetables, meats, poultry products.

**Unit IV** Statistical to quality control: Statistics relevant to quality control, quality control charts used in the food industry, process control to assure food quality, food processing.

**Unit V** Food quality standards: Food quality standards and world food trade. HACCP, ISO9000, auditing and certification.

**ABM-531 Advertising and Brand Management** **1+0** **Sem. II**

**Unit I** Introduction to Advertising Management: Integrated Marketing Communications, Setting Goals and Objectives, How advertising works: Segmentation and Positioning assess the strengths, weaknesses, opportunities and threats (SWOT) of different kinds of promotional campaigns.

**Unit II** Message Strategy: Attention and comprehension, Advertising appeals, Associating Feelings with the Brand, Brand Equity, Image and Personality and Group Influence and word of mouth advertising, Media Planning and Media Strategy, Media Strategy and Tactics, Legal, Ethical and Social concerns of Advertising.

**Unit III** Consumer Promotions and Trade Promotions: Their purpose and types How to plan and evaluate a successful promotion, The relationship between advertising and promotions, Introduction to Global Marketing, Advertising and sales promotion.

**Unit IV** Major Brand Concepts and branding Decision: Identifying and selecting brand name Building brand personality, image and identity; Brand positioning and re-launch; Brand extension; Brand portfolio; communication for branding Enhancing brand image through sponsorship and even management.

**Unit V** Managing Brand Equity and Loyalty: Brand Building in Different Sectors - Customers, industrial, retail and service brands. Building brands through Internet, social Media. Building Indian brands for global markets.

**ABM-532 Agri Infrastructure and Warehousing Management** **1+0** **Sem. II**

**Unit I** Agricultural Infrastructure in India: Incentive schemes, Agri-infra fund, Agri-market Infrastructure, Agri-technological infrastructure fund, Central Government policy on Infrastructure promotion for the development of primary sector such as Irrigation, Watershed development, Rural electrification, Connectivity, Communication and Markets in coordination with the Institutional framework

**Unit II** Warehouse Functions: Meaning of Warehousing - Importance –Functions: Receiving: Logistics support for Inward Transportation, Unloading, Inspection, Acceptance and Recording; Storing: Space allocation, Facilitation to stocking, Guarding &Recording; Risk bearing- Processing- Grading and branding – Disinfecting services -Issuing: Order preparation, Picking, Dispatching/ Delivery & Recording-Handling, Transportation & Storage of ISO Containers– Utility and Advantages of warehouses- Problems and issues in receiving processes.

**Unit III** Warehouse Types, Characteristics: Warehouse Types, Characteristics of ideal warehouses-Warehouse Layout-Principles and Facilities- Types, Internal Operations: Measures and metrics of warehouse operations, Logistics in the warehouse- Localization of materials in a warehouse, Identification and classification of Materials and products in the warehouse, managing the material/products turns in warehouse (FIFO/LIFO) - Problems and issues in shipment processes. Warehousing Equipment, Inventory management.

**Unit IV** IT for Warehouse Management (WM): Warehouse documentation- Information flows in the warehouse- ERP-WMS - Bar code – RFID- Organization Data- Warehouse Structure- Warehouse Master

Data - WM Material master view- Organization Data- Define Warehouse structure, Warehouse number - Storage type- Storage section - Storage Bin - Picking Area - Storage unit – Quantity- Creating Transfer requirement automatically/ manually – Creating Transfer requirement for storage.

**Unit V** Agri-warehousing Management in India: Agri-warehousing in India, capacity development and utilization, Role and significance of Central Warehousing Corporation, State warehousing Corporation, Private sector in Agri-warehousing. Status of Warehousing Industry: Agri warehousing organizations in India, e-NAM to promote agri-warehouse.

**ABM-533 Contract Farming** **1+0** **Sem. II**

**Unit I** Need for contract farming: objectives and its definition; contract farming framework, contract farming arrangement-centralized model, nucleus estate model, multipartite model, informal model, and intermediary model.

**Unit II** Project formulation and management: Coordination, crop husbandry, human resource. Advantages of contract farming for farmers and sponsors and the problems faced by them.

**Unit III** Policies for promoting contract farming: Agreement for contract farming-parties, duration, produce and quality specification, delivery arrangements pricing, insurance, support services etc.

**Unit IV** Prospects of contract farming in India: Prospects of contract farming in India in view of interest for commercialization of agriculture. Active organizations in contract farming and their success stories.

**Unit V** Global issues: local issues in contract farming, Contract farming and WTO agreement.

**ABM-534 Human Resource Competence and Capacity Building Systems** **1+0** **Sem. II**

**Unit I** Human Resource competence: Concept and rationale; processes, Organization and Management of competence and competency mapping.

**Unit II** Competency modelling and assessment: Approaches, tools and techniques, competency based human resource management applications.

**Unit III** Competency based training and development: Training methods compared with objectives, learning process and facilities, Developing Group and the Climate: the social process indicators of group development, the training climate, Trainers and Training Style: Post training support for improved performance at work.

**Unit IV** Performance Management System: Establishing and operationalizing performance management system; measuring performance- results and behavior; conducting performance review discussions; harnessing performance management system for performance improvement.

**Unit V** Capacity building systems in agriculture and agri business: Capacity building of farmers and agri stakeholders through e-learning, knowledge management for agri business.

**ABM-535 Agri Commodity Markets and Futures Trading** **1+0** **Sem. I**

**Unit I** Introduction to commodity derivatives and price risk management in agricultural markets; organizational setup of exchanges and specifications of futures contracts in world's leading commodity exchanges.

**Unit II** Futures trading; hedging price risk using futures contracts; option transaction and forward transaction – concept and mechanism, price discovery mechanism and market efficiency.

**Unit III** Clearinghouse and margin system; clearing, settlement and delivery of contracts.

**Unit IV** Market surveillance and risk control; trading in warehouse receipts (WRs): WRs and collateralized commodity financing.

**Unit V** Regulation of futures and trading practices in leading national and regional exchanges in India.

**ABM-536 Strategic Management for Agribusiness Enterprises** **2+0** **Sem. II**

**Unit I** Introduction - Concepts in Strategic Management, Strategic Management Process; Corporate

Governance, Social Responsibility and Ethics in strategic management, Environment Scanning and Industry analysis.

**Unit II** Organization appraisal and strategy formulation: organizational dynamics and structuring organizational appraisal, business models and Value chain analysis, Strategy formulation- corporate level strategies and business strategies, Generic Strategies- Types of Strategies, tools and techniques for strategic analysis.

**Unit III** Turnaround and Diversification Strategies: Turnaround strategy - Management of Strategic Change, Strategies for Mergers, Acquisitions, Takeovers and Joint Ventures - Diversification Strategy.

**Unit IV** Strategy implementation and control: aspects, structures, design and change: behavioral implementation-leadership, culture, value and ethics, strategic evaluation and control-an overview and techniques of strategic evaluation and control.

**Unit V** Strategic issues in managing technology & innovation, entrepreneurial ventures and small businesses, Cases in strategic management.

**ABM-537 Operations Research in Business** **2+0** **Sem. II**

**Unit I** Linear Programming: Objective, Assumptions, Formulation of Linear Programming Problem, Data Envelopment Analysis, Graphic Method, Simplex method, Introduction to Dynamic Programming, Transportation and Assignment Problems.

**Unit II** Inventory control Models: Costs Involved in Inventory Management, Types of Inventory, Economic Order Quantity (EOQ) Model, Continuous Review (Q) System, Periodic Review (P) System, and Hybrid System.

**Unit III** Waiting Line Models: Waiting Line Problem, Characteristics of a Waiting- Line System, Single-Channel Model, Multiple-Channel Model, Constant-Service Time Model, Finite Population Model, Sequencing and Replacement models.

**Unit IV** Decision making under Risk and uncertainties, Decision problem, Maximax Criterion, Maximin Criterion, Minimax Regret Criterion, Laplace Criterion, Pay off Tables, Decision Trees, Expected Value of perfect Information, stochastic models, neural networks, Markov process.

**Unit V** Game Theory - Two -Person Zero-Sum Game, Simulation, Network analysis–PERT& CPM. Financial Engineering.

**ABM-538 Financial Management in Agribusiness** **2+0** **Sem. II**

**Unit I** Meaning, importance, nature and scope of financing in India, agribusiness financing in India; classification and credit need in changing agriculture scenario; finance functions, investment financing, Risk and return concept & analysis

**Unit II** Business Financing System in India, Money and Capital Markets, Regional and All - India Financial Institutions; venture capital financing and its stages, International financial management.

**Unit III** Features, types and Techniques of capital budgeting decision. Cost of Capital, Leverage analysis, Capital structure. Theory and Policy, Sources of Long and Short-term finance, Dividend Theory, Dividend Policy.

**Unit IV** Management of Working Capital, Management of Receivables, Management of cash Cash budget, Management of collections and disbursement, Investment of Surplus cash.

**Unit V** Perspectives and operational aspects of Micro finance: Definition, Scope and importance of Micro Finance, Evolution of Micro Finance in India, Micro Finance credit lending models: Association model, Community Banking model, Credit union model, Co-operative model, SHG model, Village Banking model.

**ABM-539 Communication for Management and Agribusiness** **2+1** **Sem. I**

**Unit I** Communication process, barriers to communication, methods of communication, effective communication, assertive communication, types of organizational communication. Listening skills, active listening, barriers to effective listening, Non Verbal Communication.

**Unit II** Reading comprehension and techniques, rules of good writing, business letter writing- mail writing, crafting messages for electronic media, social media, business blogs, podcasts, and employment messages.

**Unit III** Visual presentation, oral presentation skills, conducting business meetings, brainstorming sessions and presentations, public speaking skills, Communicating across cultures, Various forms of scientific writings, theses, technical papers, reviews, manuals, research work, various parts of thesis and research communication Title page, authorship, contents, preface, introduction, review of literature, material and methods, experimental results and discussion, Technical Writing Style and Editing, Writing Introductions & Conclusions, Editing and Proof reading, Writing a review article and book summary.

**Unit IV** Developing interpersonal skills (transactional analysis), Business Etiquettes, essentials of business conversations. Business meeting agenda and minutes, circulars and sales letters, notices, overview of business proposals.

**Unit V** Developing self-awareness (Johari Window), solving problems analytically and creatively, introduction to case method of learning, case reading, approaches and analysis.

**Practical :** Case Studies.

**ABM-540 Research Methodology for Agribusiness Management 2+1 Sem. II**

**Unit I** Meaning, Course Objective, types, and process of research; research methodology in management- exploratory, descriptive, experimental, diagnostic, Problem formulation, setting of Course Objective, formulation of hypotheses, models, types of models, process of modeling.

**Unit II** Scales of measurement - nominal, ordinal, interval, ratio, Likert scale and other scales; Primary and secondary data, sources of data, Questionnaire Designing, instruments of data collection, data editing, classification, coding, validation, tabulation, presentation, analysis, development process of scale, identification of variables, variable measurement, variable standardization and dummy variables.

**Unit III** Introduction to multivariate statistical analysis techniques, Multivariate linear regression models, principal component analysis, linear discriminant analysis, factor analysis, evaluation matrices and model diagnostics for regression models.

**Unit IV** Logistic regression, decision trees, cluster analysis, random forest, GARCH, CART models, support vector machines, Forecasting techniques (AR, MA, ARMA and ARIMA models).

**Unit V** Definition, scope and importance, machine learning, types of machine learning, linear and nonlinear models in machine learning, introduction to deep learning, basic differences in machine learning and deep learning, concept of cloud machine learning, Big data analysis.

**Practical :** Case Studies, Group Discussions, Practical Use of Software.

**ABM-541 Computer Applications for Agribusiness 2+1 Sem. I**

**Unit I** Concept of Computers- Brief History of Computers, Generation and Its Evolution, Characteristics of Computers, Main Areas of Computers and their Applications; Classification of Computers, Input-Output Devices, Memory Types (Cache, RAM, ROM), Memory Units.

**Unit II** System Software and Application Software, Open source software, introduction to computer languages, Introduction to Operating Systems – Functions, Features and Types., MS Windows and LINUX. Data Base Management System, MS Office (MS Word, MS Power Point, MS Excel, MS-Access and use of various management software Like SPSS, SAS etc.

**Unit III** The business value of internet, Intranet, extranet and Internet, Introduction to Web page design using HTML, Cloud Computing, Security and ethical challenges: Computer crime – Hacking, cyber theft, and unauthorized use at work. Piracy – software and intellectual property. Health and Social Issues, Ergonomics and cyber terrorism.

**Unit IV** The concept of MIS–Definition, importance, Course Objective, pre- requisites, advantages and challenges; Information Needs of organization, MIS and Decision – Making. Types/Classification of Information System for organizations; Introduction to Artificial Intelligence (AI), Neural Networks, Fuzzy logical control systems.

**Unit V** E business/ e commerce: e business models, e commerce processes, electronic payment systems, e- commerce trends with special reference to agri business. Applications of MIS in the areas of Human Resource Management, Financial Management, Production/Operations Management, Materials Management, Marketing Management.

**Practical:** Computer Exercises.

**ABM-542 Project Management and Agribusiness Entrepreneurship 2+1 Sem. II**

**Unit I** Concept, characteristics of projects, types of projects, project identification, and Project's life cycle. Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis.

**Unit II** Network Methods: Meaning, Network Analysis, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), Project scheduling and resource allocation. Financial appraisal/evaluation techniques- discounted/non-discounted cash flows; Net present values, profitability index, Internal rate of returns; Cost benefits ratio; Accounting rate of return, Payback period, Project implementation; Cost overrun, Project control and information system.

**Unit III** Concept of Agri Entrepreneurship: Objective, Introduction to agri entrepreneurship, Entrepreneurial Development Models, Successful Models in Agro Entrepreneurship Intrapreneur, Development of women entrepreneurship with reference to SHGs, Social entrepreneurship.

**Unit IV** Creativity, Innovation and Agro Entrepreneur: Inventions and Innovation, The Environment and Process of Creativity, Creativity and the Entrepreneur, Innovative Approaches to Agro Entrepreneurship, Business Incubation, Steps and Procedure to start a new business, Business Opportunities in different field of Agriculture and Allied Sectors.

**Unit V** Sources of Financing, Structure and Government Policy Support: Estimating Financial Requirements, Preparation of Detail Project Report, Project Appraisal, Sources of Long- Term Financing, Working Capital Financing, Venture Capitalist, Finance from Banking Institutions, Industrial Policy Resolutions in India, Incentives and Subsidies, Schemes for Incentives, Government Organizations like SIDO, DIC, KVIC, NSIC, SIDBI, NABARD and their role, Sick Industries and their Up gradation policy measures.

**Practical :** Case Studies, Group Discussion and Preparation of Business Plan.

**ABM-543 Agribusiness Environment and Policy 2+0 Sem. II**

**Unit I** Role of agriculture in Indian economy; Problems of agriculture in India; Agribusiness– definition and nature, Structure of Agriculture and linkages among sub-sectors of the agribusiness.

**Unit II** Economic reforms: liberalization, privatization and globalization specifically affecting Agri Business; WTO Agreement on Agriculture and its compliances; changes in policies and regulations related to the sub sectors of agribusiness and its impact on agribusiness in India.

**Unit III** Emerging trends in farm supplies, farm production, agricultural finance, agro processing, international trade etc.; reforms in agri output markets: private markets, contract farming, futures trading in agri commodities and e-NAM etc., Pricing of agricultural outputs, public distribution system, imports and exports.

**Unit IV** Importance of food safety and quality management in agri business; Environmental issues and including carbon markets and Clean Development Management etc.

**Unit V** Other major issues: Intellectual property rights, importance of cooperative or collective actions in present scenario with examples of mergers and acquisitions, Farmers Producer Organizations etc.

**ABM-544 Agribusiness Laws and Ethics 2+0 Sem. I**

**Unit I** Introduction to Indian legal system, The Indian Contract Act-1872: Contract meaning, types of contract, essentials of a valid contract, offer and acceptance, capacity to contract, free consent, performance of contract.

**Unit II** Law of Negotiable Instruments: Promissory Notes, Bills of Exchange, Cheques and Bank Drafts, Endorsements, Law of Sale of Goods, Sales of Goods Act-1930-: Sale and agreement to sale, types of goods, Transfer of property in goods, mode of delivery of goods, performance of contract of sales, rights of an unpaid seller.

**Unit III** Companies Act-1956: incorporation, commencement of business, types of companies, management of company, Memorandum of Association and Articles of Association, prospectus, winding of companies.

**Unit IV** Essential Commodities Act, Consumer Protection Act, RTI Act, MRTP Act- major provisions and implications. Competition Act-2002, Regulatory environment for International Business

**Unit V** Nature and importance of ethics and moral standards; corporations and social responsibilities, scope and purpose of business ethics; Ethics in business functional areas; industrial espionage; solving ethical problems; governance mechanism. Implementing business ethics in a global economy.

| | | |
|---|---|---|
| **ABM-591 Seminar** | **1+0** | **Sem. I** |
| **ABM-595 Summer Internship** | **0+4 NC** | **Sem. II** |
| **ABM-599 Project Work** | **0+10 NC** | **Sem. I/II** |

# CHEMISTRY

## PROGRAMMES

**M. Sc.**

**Ph.D.**

**Five Year Integrated M.Sc. (Hons.)**

## COURSE REQUIREMENT

### M.Sc.

| | |
|---|---|
| Field of specialization | Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Agrochemicals |
| Required courses | Chem.-501, Chem.-502, Chem.-503, Chem.-504, Chem.-505 |
| Supporting courses | Stat.-502 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Botany, Biochemistry, Microbiology, Mathematics, Statistics, Physics, Entomology, Plant Pathology, Soils, Agronomy or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

### Ph.D.

| | |
|---|---|
| Field of specialization | Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Agrochemicals |
| Required courses | Chem.-601 |
| Supporting courses | Courses from subject matter fields (other than Minor) relating to area special interest and research problem. |
| Minor field | Botany, Biochemistry, Microbiology, Mathematics, Statistics, Physics, Entomology, Plant Pathology, Soils, Agronomy or any other as approved by the Dean Postgraduate Studies |
| Deficiency courses | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Five Year Integrated M.Sc. (Hons.)

| | |
|---|---|
| Field of specialization | Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Agrochemicals |
| Required courses | All courses listed for Semester I-VI and Chem.501, Chem.502, Chem.503, Chem.504, Chem.505. |
| Common courses | PGS-501, PGS-502,PGS-503, PGS-504, PGS-505 |
| Supporting courses | Stat.-502 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Minor fields | Botany, Biochemistry, Microbiology, Mathematics, Statistics, Physics, Entomology, Plant Pathology, Soils, Agronomy or any other as approved by the Dean Postgraduate Studies |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses/ Integrated M.Sc. (Hons)

**Chem. 91 Introductory Inorganic Chemistry** **3+1** **Sem. I**

Basic concepts of chemistry: Classification and nature of matter, laws of chemical combination, Dalton's atomic theory: Concept of elements, atoms and molecules. Atomic and molecular masses and mole concept percentage composition, empirical and molecular formula, Atomic structure: Fundamental particles, Discovery of electron, proton and neutron, atomic number, isotopes and isobars, Thompson's model and its limitations, Rutherford and Bohr model of atom and limitations, concepts of shells and sub shells, dual nature of matter and light, de Broglie's relationship, Heisenberg principle, Quantum numbers, shapes of orbital's rules for filling electrons in orbital's Aufbau principle, Pauli exclusion and Hund's rule and electronic configurations of elements, stability of half filled and completely filled orbitals. Classification of elements and periodicity in properties: Brief History of the development of the periodic table, Modern periodic law, Mendeleev's and modern periodic table, types of elements: s, p, d, f-block elements, periodic trends in properties; Atomic Radii, ionic radii, ionization energy and electron affinity and electro negativity, inert gas radii, ionization enthalpy, electron gain enthalpy, Chemical bonding and molecular structure: Valence electrons, Ionic bond, bond parameters, Covalent bond, Lewis structure, polar character of covalent bond, Valence bond theory, Resonance, VSEPR theory, Concept of hybridization involving s, p and d orbitals and shape of some simple molecules. Molecular orbital theory of homonuclear diatomic molecules (qualitative idea only), hydrogen bond. States of matter: Three states of matter, Role of gas laws in elucidating the concept of the molecule, Boyle's Law, Charles law, Gay lussac's law, Avogadro's Law, Ideal behavior, empirical derivation of gas equation, Avogardro's number, ideal gas equation,. Derivation from ideal behaviour,kinetic energy and molecular speeds (elementary idea) s-Block elements: General Introduction, occurrence, electronic configuration, diagonal relationship, trends in physical and chemical properties, such as ionization energy, atomic radii, trends in chemical reactivity with oxygen, water, hydrogen and halogens. p-block elements: Group 16 elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties,sulphuric acid: industrial process of manufacture, properties and uses, oxoacids of sulphur (structures only). Group 17 elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties;uses of chlorine and hydrochloric acid, interhalogen compounds, oxoacids of halogens (structures only). Group 18 elements: (General introduction, electronic configuration, Oxidation state, Occurrence, trends in physical and chemical properties, uses. d-and f-Block Elements: General introduction, electronic configuration, oxidation state, characteristics of transition metals, metallic character, ionization enthalpy, , ionic radii, colour, catalytic property, magnetic properties, interstitial compounds. Lanthanides-electronic configuration, oxidation states, chemical reactivity and lanthanide contraction.

Actinides: Electronic configuration, oxidation states. Coordination chemistry: Coordination compounds introduction, ligands, coordination number,IUPAC nomenclature of mononuclear coordination compounds. bonding; Werner's theory, VBT, CFT, isomerism. General principles and processes of Isolation of Elements: Principles and methods of extraction - concentration, oxidation, reduction electrolytic method and refining, occurrence and principles of extraction of aluminium, copper, zinc and Iron. Hydrogen: Position of hydrogen in periodic table, Occurrence, Isotopes, Preparation, properties, and uses of hydrogen, hydrides-ionic, covalent and interstitial, physical and chemical properties of water, heavy water, hydrogen peroxide, hydrogen as a fuel.

**Practical :** Introduction about basic laboratory techniques, crystallization of impure samples copper sulfate, alum, Quantitaive estimation: Preparation of a standard solution of oxalic acid, Determination of strength of a given solution of sodium hydroxide by titrating it against standard solution of oxalic acid, determination of molarity and strength of potassium permanganate solution by titrating it with standard solution of Mohr's salt, Determination of strength of a given solution of hydrochloric acid by titrating it against standard sodium carbonate solution. Chemical equilibrium: Study of shift in equilibrium between ferric ions and thiocyanate ions. Qualitative analysis: Determination of one anion and one cation in a

given salt: Cations: $Pb^{2+}$, $Cu^{2+}$, $As^{3+}$, $Al^{3+}$, $Fe^{3+}$, $Mn^{3+}$, $Ni^{2+}$, $Zn^{2+}$, $Co^{2+}$, $Ca^{2+}$, $Sr^{2+}$, $Ba^{2+}$, $Mg^{2+}$, $NH_4^+$.Anions: $Co_3^{2-}$, $S^{2-}$, $SO_3^{2-}$, $SO_4^{2-}$, $NO_2^-$,$NO_3^-$, $Cl^-$, $Br^-$, $I^-$, $PO_4^{3-}$, $C_2O_4^{2-}$, $CH_3COO^-$.

**Chem. 92 Organic Chemistry-I** **3+1** **Sem. II**

Some Basic Principles and Techniques in Organic Chemistry: General introduction, methods of purification, qualitative and quantitative analysis, Classification and IUPAC nomenclature of organic compounds. Electronic displacements in a covalent bond: inductive effect, electromeric effect, resonance and hyper conjugation. Homolytic and heterolytic cleavage of covalent bond, Reaction intermediates: structure and stability of free radicals, carbocations and carbanions, Concept of electrophiles and nucleophiles and types of organic reactions. Classification of hydrocarbons: Alkanes-Nomenclature, structure, isomerism, conformations(ethane only) physical properties methods of preparation and chemical reactions of alkanes, free radical mechanism of halogenation, combustion and pyrolysis of alkanes, Alkenes-Nomenclature structure of double bond (ethene) geometrical isomerism physical properties methods of preparation and chemical reactions: Addition of hydrogen, halogen, water, hydrogen halides (Markownikoff's addition and peroxide effect), ozonolysis, mechanism of electrophilic addition. Alkynes- Nomenclature, structure of triple bond (ethyne), physical properties, methods of preparation and chemical reactions, acidic character of alkynes and addition reaction of hydrogen ,halogen, hydrogen halides and water, Aromatic Hydrocarbons- Introduction, IUPAC nomenclature, resonance, benzene, aromaticity, chemical properties mechanism of electrophilic substitution reactions, – nitration, sulfonation, halogenations, Friedel Craft's alkylation and acylation: directive influence of functional group in mono-substituted benzene; carcinogenicity and toxicity. Environmental pollution- Air, water and soil pollution, chemical reactions in atmosphere, smog, acid rain, ozone and its reactions, Effects of depletion of ozone layer, greenhouse effect and global warming, industrial pollution, Green chemistry as an alternative tool for reducing pollution, strategy for control of environmental pollution.

**Practical :** Determination of melting point and boiling point of an organic compound, Crystallization of impure sample of benzoic acid. Preparation of aspirin, iodoform, analysis of fruits and vegetable juices for their acidity, Detection of nitrogen, sulfur, chlorine in organic compounds, Test for the functional groups present in organic compounds:Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (primary) groups.

**Chem. 93 Fundamentals of Physical Chemistry** **3+1** **Sem. I**

Solid state: Structure of ionic solids, close packed structure, classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea), unit cell in two dimensional and three dimensional lattices, calculation of density of unit cell, packing in solids, voids, number of atoms per unit cell in a cubic unit cell, points defects, electrical and magnetic properties imperfections in solids and silicates. Band theory of metals, conductors, semiconductors and insulators and n and p type semi-conductors. Solutions: Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, vapour pressure of solutions, Raoult's law, colligative properties; relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass and non-ideal solutions. Vant Hoff factor. Chemical energetic and laws of thermodynamics: Concept of system and its types, surrounding, work, heat, energy, extensive and intensive properties, state functions, first Law of thermodynamics, Internal energy, Enthalpy, Heat capacity, specific heat, measurement of $\Delta U$ and $\Delta H$, Hess's law of constant heat summation, Enthalpy of bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization, solution and dilution, Introduction to entropy as a state function, Gibb's free energy change for spontaneous and non-spontaneous processes, criteria for equilibrium, second law of thermodynamics, third law of thermodynamics (brief introduction). Chemical equilibrium: Equilibrium in physical and chemical processes, dynamic nature of equilibrium, Law of mass action, Equilibrium constant, factors affecting equilibrium- Le Chatelier's principle, Ionic Equilibrium, Ionization of acids and bases, Strong and weak electrolytes, Degree of Ionization, ionization of polybasic acids, acid strength, Concept of pH, Henderson equation, Hydrolysis of salts (elementary idea), Buffer solutions, Solubility product, Common ion effects (with illustrative examples). Redox reactions: Oxidation and reduction, oxidation number and redox

reactions in aqueous solution. Balancing redox reactions, Application of redox reactions. Chemical kinetics: Rate of reactions (average and instantaneous), order and molecularity of reactions; factors affecting rate of reactions; concentration, temperature, catalyst; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment)photochemical reactions and mechanism of reactions. Nuclear Chemistry: Natural radioactivity – discovery and historical development, Radioactivity, nuclear structure and properties, radioactive disintegration series, nuclear fusion and fission, group displacement law and nuclear reaction, rate of radioactive disintegration, artificial transmutation, breeder reactor, transuranic elements and applications. Synthetic and natural polymers: Classification, preparation and properties of natural and synthetic polymers and application of polymers. Surface chemistry: Concept of adsorption, physical and chemical; factors affecting adsorption of gases on solids; colloids; preparation and properties, colloidal state: distinction between true solutions, colloids and suspensions; lyophilic, lyophobic, multimolecular and macromolecular colloids, Tyndall effect, Brownian movement, catalysis, homogenous and heterogeneous, activity and selectivity, enzyme catalysis; electrophoresis, coagulation, emulsions types of emulsions. Electrochemistry: Redox reactions, conductance in electrolyte solutions, specific and molar conductivity, variation of conductance with concentration, Kohlrausch's law, electrolysis and laws of electrolysis (elementary idea) dry cells – electrolytic cells and galvanic cells, lead accumulators, EMF of a cell, standard electrode potential, Nernst equation and its applications to chemical cells, fuel cells, corrosion, relation between Gibbs energy change and EMF of a cell.

**Practical** : Preparation of lyophilic and lyophobic sol, determination of enthalpy of neutralization of strong acid and strong base, Determination of enthalpy change during interaction between acetone and chloroform, Enthalpy of dissolution of copper sulfate or potassium nitrate, study of rate of Reaction between potassium iodate, $KIO_3$ and sodium sulphite : using starch solution as indicator, rate of reaction of ester hydrolysis, determination of molarity and strength of potassium permaganate solution by titrating it with standard solution of oxalic acid, determination of conductance of ions in a given sample, determination of refractive index of given liquids, determination of pH of given liquids using pH paper, universal indicator and pH meter, study of adsorption of oxalic acid on activated charcoal, study the viscosity and surface tension of the given liquids, determine the temporary and permanent hardness of water.

**Chem. 94 Organic Chemistry-II** **3+1** **Sem. II**

Haloalkanes and haloarenes: Nomenclature, nature of C-X bond physical and chemical properties mechanism of substitution reactions, optical rotation reactivity of C-X bond in haloalkanes and haloarenes, influence of halogen for monosubstituted compounds only) uses and environmental effects of Dichloro, Trichloro and Tetrachloromethanes, BHC, DDT, Freons and Iodoform. Alcohols: Nomenclature methods of preparation, physical and chemical properties (of primary alcohols only); identification of primary, secondary and tertiary alcohols; mechanism of dehydration, uses, with special reference to - methanol and ethanol. Phenols: Nomenclature methods of preparation, physical and Chemical reactivity of phenols in electrophilic substitutions, acidic nature of phenol, uses of phenols. Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses. Aldehydes and Ketones: Nomenclature, electronic structure of carbonyl group, methods of preparation, physical and chemical properties, and mechanism of nucleophilic addition, relative reactivity of aldehydic and ketonic groups, acidity of alpha-hydrogen, aldol condensation, cannizzarro reaction. Carboxylic acids and their derivatives: Nomenclature, electronic structure of-COOH, Important methods of preparation from aldehydes, ketones, alcohols and cyanides, physical and chemical properties, acidic nature, effect of substituents on alpha-carbon on acid strength, chemical reactions: Decarboxylation, etherification, Dehydration, relative reactivity of various acid derivatives and uses. Amines- Nomenclature classification, structure, primary, secondary and tertiary amines, methods of preparation, amination, Basic character of amines, chemical reactions, Methods to distinguish between Primary, Secondary and Tertiary amines, Dye test and Carbylamines reaction. Cyanides and isocyanides: Preparation from halides and Chemical reactions: Hydrolysis and reaction with Grignard's reagent. Diazonium salts: Preparation, chemical reaction of benzene diazonium chloride. And importance in synthetic organic chemistry. Some commercially important nitrogen containing carbon compounds (aniline and TNT). Nitro compounds: Nomenclature, Preparation from alkyl halides by nitration. Reduction reactions of nitro compounds. Biomolecules: Carbohydrates:

Classification, aldose and ketose, monosaccharides (glucose and fructose), oligosaccharides (sucrose, lactose, maltose), polysaccharides, starch, cellulose, glycogen); Important simple chemical reactions of glucose, elementary idea of structure of pentose and hexose. Proteins: Elementary idea of alpha-amino acids, peptide bond, polypeptides, proteins, primary, secondary, tertiary and quaternary structure, Denaturation of proteins, Enzymes. Vitamins: Classification and Functions, Hormones: Elementary idea (excluding structure) Nucleic acids: Chemical composition of DNA and RNA, Lipids: Classification and Structure, Polymers: Classification - natural and synthetic, Addition and condensation polymerization, copolymerization, natural rubber, vulcanization of rubber, Synthetic rubbers, Condensation polymers,. Some commercially important polymers (Polythene, polyesters, rubber, PVC, teflon, polystyrene, nylon-6 and 66, terylene and bakelite). Biodegradable and Non-Biodegradable Polymers. Chemistry in everyday life: Chemicals in medicines, analgesic, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines. Chemicals in food – Preservatives, artificial sweetening agents. Elementary idea of antioxidants. Cleansing agents – Soaps and detergents, Cleansing action.

**Practical** : Separation of pigments from extracts of leaves and flowers by paper chromatography and TLC and determination of $R_f$ values. Preparation of Organic Compounds: Acetanilide, azo dye, iodoform, urea-formaldehyde resin, study the cleansing action of different detergents, Test for the functional groups present in organic compounds: Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino(primary) groups. Study of carbohydrates, fats and proteins in pure form and detection of their presence in given food stuffs.

**Chem. 101 General Chemistry** **2+1 (NC)** **Sem. I**

Atomic structure, Rutherford's model and Bohr's atomic model, Quantum mechanical concept of atomic structure. Concept of orbitals, their shapes, Quantum numbers. Chemical bonding including ionic, covalent and co-ordinate bonds. Trivial and modern periodic table studies. Chemical energetics. Chemical equilibrium. Chemical kinetics; rate of reaction and order of reaction. Acids, bases, salts, pH, common ion effect, buffer solutions, their preparation and use in intracellular fluids. Hydrolysis of salts of strong acid and strong base, strong acid and weak base, weak acid and strong base, weak acid and weak base and solubility product. Elementary ideas about colloids, surface chemistry and catalysis, electrochemistry. Corrosion, its electrochemical theory and its prevention.

**Practical :** Analysis of a single salt. Volumetric analysis, involving acid-alkali titration and redox titration. Determination of pH and electrical conductivity. Heat of neutralization.

**Chem. 102 Introductory Organic Chemistry** **2+1** **Sem. I**

Introduction to organic chemistry. IUPAC nomenclature of carbon compounds and their isomerism in carbon compounds, hybridization, sp3 , $sp^2$ and sp, their shapes and angles, explanation of acidity of alkynes. Preparation and properties of alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, aliphatic aldehydes and ketones, aliphatic carboxylic acids and their derivatives and aliphatic amines. Introduction to aromatic compounds. Structure of benzene, aromatic hydrocarbons, preparation and properties of benzene, aryl halides, phenol, aniline, benzene sulfonic acid, benzaldehyde, acetophenone, benzoic acid. Chemistry of esters, amides, acid chlorides, cyanides and isocyanides, An introduction to substitution and elimination reaction, carbocations, carbanions and free radicals.

**Practical :** Detection of elements. Tests for functional groups. Determination of melting and boiling points. Preparation of dyes, soap and detergent.

**Chem. 201 Organic Chemistry** **3+0** **Sem. I**

Structure of benzene, heats of hydrogenation and combustion (stability), carbon-carbon bond length, resonance, orbital picture and Huckel rule of aromaticity. Aromatic substitution reactions and their mechanism involving nitration, halogenations, sulfonation, Friedal- Crafts acylation and alkylation. Reactivity and orientation, theory of reactivity and orientation. Aromatic- aliphatic compounds - arenes and their derivatives. Preparation and important reactions of aromatic aldehydes, ketones, carboxylic acids and their derivatives, halides and phenols. Nitrobenzene and its reduction products. Diazonium salts and their synthetic applications. Nucleophilic aromatic substitution. Polynuclear aromatic compounds,

nomenclature, structure, reaction and orientation of electrophilic substitution in naphthalene, anthracene and phenanthrene and their derivatives. Synthesis and structure, reactions and aromatic character of furan, pyrrole, thiophene and pyridine. Electrophilic substitution in five and six membered aromatic heterocyclic compounds. Chemistry of malonic ester and acetoacetic ester. General introduction to photochemistry.

**Chem. 202 Chemistry for Agricultural Engineering** **2+1** **Sem. II**

Phase rule and its application to one and two component systems. Fuels, classification and calorific value. Colloids, classification and properties. Corrosion and its prevention. Pollution sources and types of pollution. Analytical methods like thermogravimetric, polarographic analysis, nuclear radiation detectors and analytical applications of radioactive materials. Metallurgy of titanium, nickel and chromium. Lubricants, properties, mechanisms, classification and tests. Polymers, nomenclature, types of polymerisation, effect of structure on properties, mechanical behavior, plastic and elastomers. Resins, determination of molecular weight of polymers.

**Practical :** Volumetric, Gravimetric and Instrumental analysis. Water: Total solids, turbidity, pH value, carbonate and bicarbonate, acidity, hardness, chloride, dissolved oxygen, BOD, COD, ammonical nitrogen, coagulant, chlorine demand and residual chlorine. Chemical analysis of cement and alloys. Viscosity of bitumen, calorific value of fuels, polarimetric, conductometer and spectrophotometric analysis.

**Chem. 203 Physical and Inorganic Chemistry** **2+1** **Sem. II**

Law of thermodynamics, concept of free energy, Partial molar quantities, chemical potential, Kirchhoff's equation. Application of thermodynamics in understanding energies in living cells. Differential rate law and integrated rate expression. Half life time of a reaction. Concept of activation energy. Reaction mechanism, steady state hypothesis. Catalysis: Homogenous catalysis, enzyme catalysis, Heterogeneous catalysis unimolecular surface reaction. Debye-Huckel theory of strong electrolytes, Transport number, Polarography, Half wave potential. The Schrödinger equation and postulates of quantum mechanics, Normal and orthogonal wave function, solution of Schrödinger wave equation for one and three dimensional box. Metal - ligand bonding in transition metal complexes, magnetic properties of transition metal complexes. Thermodynamic and Kinetic aspects of metal complexes. Hard and soft acids and bases. Organometallic compounds.

**Practical :** Separation and identification of ions (4-ions with no interference), Preparation of metal complexes, Experiments involving conductometer, pH meter, spectrophotometer, refractometer, polarimeter. Experiments concerning adsorption, solutions and chemical kinetics.

**Chem. 204 Mechanism of organic reactions** **2+1** **Sem. II**

Types of organic reactions, Reaction intermediates, assigning formal charges on intermediates and other ionic species. Methods for determination of reaction mechanism (product analysis, intermediates, isotope effect, kinetic and stereochemical studies).Mechanism of free radical halogenation of alkanes; orientation, reactivity and selectivity. Aromatic Electrophilic Substitution-Mechanism of nitration, halogenation, sulfonation and Friedel craft reaction. Concept of isomerism, types of isomerism (optical, geometrical and conformational isomerism) stereoselective and stereospecific reactions. Stereochemistry of addition of halogens to alkenes, Stereochemistry of elimination reactions. Spectroscopy: Introduction to infrared, ultraviolet visible and proton NMR spectroscopy. Use of these spectroscopic techniques for structural elucidation.

**Practical :** Use of chromatography in the separation and identification of organic compounds in a mixture. Identification of elements and functional groups in organic compounds. Single step preparation of organic compounds.

**Chem. 205 Engineering Chemistry** **2+1** **Sem. I**

Phase rule and its application to one and two component systems. Fuels: classification, calorific value. Colloids: classification and properties. Corrosion: causes, types and methods of prevention. Water; temporary and permanent hardness, disadvantages of hard water, scale and sludge formation and corrosion in boiler. Analytical methods like thermogravimetric, polarographic analysis, nuclear radiation,

detectors and analytical applications of radioactive materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Principles of food chemistry, introduction to lipids, proteins, carbohydrates, vitamins, food preservators, coloring and flavoring reagents of food. Lubricants; properties, mechanism, classification and tests. Polymers: types of polymerization, properties, uses and methods for the determination of molecular weight of polymers. Introduction to IR spectroscopy.

**Practical :** Determination of temporary and permanent hardness of water by EDTA method. Estimation of chloride in water. Estimation of dissolved oxygen in water. Determination of BOD in water sample. Determination COD in water sample. Estimation of available chlorine in bleaching powder. Determination of viscosity of oil. Estimation of activity of water sample. Estimation of alkalinity of water sample. Determination of carbonate and non-carbonate hardness by soda reagent. Determination coagulation of water and chloride ion content. Determination of specific rotation of an optically active compound. max and verification of Lambert Beer's Law. Determination of calorific value of fuel.λDetermination of Identification of functional groups (alcohol, aldehyde, ketone, carboxylic acid and amide) by IR. Chromatographic analysis. Determination of molar refraction of organic compounds.

**Chem. 301 Fundamental Organic Chemistry** **3+0** **Sem. I**

Classification, nomenclature and preparation of alkyl halides. Mechanism, kinetics, stereochemistry, role of solvents in substitution and elimination reactions. Homogenous hydrogenation in alkenes and its stereochemistry. Mechanism and orientation of free radical addition and substitution in alkenes. Allyl radical, its stability and orbital picture. Electrophilic addition to conjugated dienes. Introduction, structure, classification and nomenclature of alcohols. Orientation, stereochemistry and mechanism of hydroboration reaction. Study of stereochemistry, intramolecular nucleophilic attack, Anchimeric effect in the cleavage of C--OH bond of alcohols, biological oxidation of ethanol. Chemistry of benzene, the Huckel 4n+2) rule. Structure, nomenclature and chemistry of aldehydes and ketones. Alkylation of carbonyl compounds via enamines. Preparation of ketones by Friedel-Crafts acylation and use of organocopper compounds. Pinacol rearrangement, acetal formation and Cannizzaro reaction. Ionization, acidity constant, equilibrium, acidity, effect of substituents on acidity of carboxylic acids. Grignard's synthesis and reactions of carboxylic acids. Aldol condensation.Witting reaction, Claisen condensation, Reformatsky reaction. Structure, classification nomenclature and chemistry of amines and phenols.The chemistry of sulfa drugs and diazonium salts. Syntheses and chemical reactions of malonic acid and acetoacetic acid. Chemistry of naphthalene, anthracene and phenanthrene.

**Chem. 302 Chemistry of Agrochemicals, Plant Products and Growth Regulators** **1+1** **Sem. I**

Organic chemistry as prelude to agrochemicals. Diverse types of agrochemicals. Botanical insecticides (neem), pyrethrum and synthetic pyrethroids. Synthetic organic insecticides, major classes, chemistry and use of some important insecticides under each class. Herbicides-major classes, chemistry and use of 2,4-D, atrazine, glyphosate, butachlor, benthiocarb. Fungicides - major classes, Chemistry and use of carbendazim, carboxin, captan, tridemorph and copper oxychloride. Plant growth regulators.

**Practical :** Argentometric and iodometric titrations - their use in the analysis of important pesticides. Compatibility of fertilizers with pesticides.

**Chem. 303 Thermodynamics and Chemical Kinetics** **3+0** **Sem. II**

Types of system, state and path function. First law of thermodynamics, Heat capacity Cp and Cv, Kirchoff's equation, calculation W, q, dU and dH for expansion of ideal gas under isothermal and adiabatic conditions, Joule Thomson effect, Joule Thomson coefficient, Zeroth law of thermodynamics, Absolute temperature scale. Second law of thermodynamics, Carnot cycle, concept of entropy and third law of thermodynamics, Nernst heat theorem, Concept of residual entropy. Gibb's function (G) Helmholtz function (A), variation of G & A with P, V and T, Claussius inequality, Entropy change in mixing of ideal gases. Entropy as a function of V and T, Entropy as a function of P and T. Chemical kinetics, Factors influencing reaction rate, Mathematical derivation of rate equation for zero, first and second order reactions, half life, Pseudo unimolecular reactions. Homogeneous and heterogeneous catalysis, Acid base & enzyme catalysis, Michaelis Mentan equation for enzyme catalysis.

**Chem. 304 Basic Analytical Chemistry** **3+0 Sem. II**

Accuracy and precision, Significant figures, determinate and indeterminate errors. Chromatography, types of chromatography, High performance liquid chromatography, principle, instrumentation and its applications, Paper chromatography, Thin layer chromatography, Column chromatography and Gas liquid chromatography.Conductometric methods; Measurement of conductance, Conductometric titrations and variation of equivalent conductance with dilution. Analytical reagents, EDTA, cerate and Iodate. Gravimetric analysis, Examples, organic precipitates, precipitation equilibria and diverse ion effect. Colorimetry-Introduction, derivation of Beers law, Applications of colorimetry and spectrophotometry. Potentiometric titrations, types of potentiometric titrations, Advantages of potentiometric titrations. pH, Ion selective electrode, Instrumentation, application of pH measurements. Electrogravimetry, theory, instrumentation and applications.

**Chem. 305 Experiments in Inorganic Chemistry** **0+2 Sem. II**

**Practical** : Quantitative analysis of inorganic mixture of four (4) ions with one interfering anion. Chromatographic separation of $Cl^-$ , $Br^-$ and $I^-$ ; $Cd^{2+}$ and $Hg^{2+}$. Colorimetric determination of Ni as Ni-diglyoxime complex, Pb as dithiazone complex and Al (or Mg) as oxinate complex. Preparation of aluminium acetylacetonate, Cu (I) thiourea, Potassium trioxalato chromate (III) and Mohr's salt.

**Chem. 306 Fundamental Inorganic Chemistry** **2+0 Sem. I**

SBlock elements; oxides, hydroxides, hydrides, halides, solvation and complexation tendencies, crown and cryptans. p Block elements; variation of periodic properties, oxides, oxoacids, hydrides and halides, preparation and structure of boranes, structure of silicates, silicones, phosphazenes, compounds of sulphur and nitrogen. Preparation and properties of inter halogen compounds, clathrates. Structure, properties and preparation of noble gas compounds. Non aqueous solvents, liquid ammonia, sulfur dioxide and hydrogen fluoride as solvents, characteristic properties and reactions. Acids and bases, Bronsted Lowry, Lewis and Pearson's concepts of acids and bases, HSAB principle and its application.

**Chem. 308 Chemistry of Agrochemicals** **2+1 Sem. II**

Agrochemicals- introduction, types, role in agriculture, effect on environment, soil, human and animal health, merits and demerits of uses in agriculture. Management of agrochemicals for sustainable agriculture. Herbicides-major classes, properties and fate of important herbicides. Classification of fungicides. Inorganic fungicides - characteristics, preparation, use and mode of action of bordeaux mixture and copper oxychloride. Organic fungicides- mode of action, characteristics, preparation and use of dithiocarbamates- zineb and maneb. Systemic fungicides- characteristics and use of benomyl, carboxin, oxycarboxin, metalaxyl, carbendazim. Introduction and classification of insecticides-inorganic and organic insecticides. Uses of organochlorine, organophosphates, carbamates, synthetic pyrethroids neonicotinoids. Insecticide act and rules. Banned, withdrawn and restricted use insecticides. Insect growth regulators (IGRs), biopesticides, reduced risk insecticides-botanicals. Plant and animal systemic insecticides. Fertilizers and their importance. Nitrogenous and phosphatic fertilizers-feedstocks and manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea, slow release N-fertilizers and single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers-natural sources of potash, manufacturing of potassium chloride, potassium sulphate and potassium nitrate.Mixed and complex fertilizers- sources and compatibility. Preparation of major, secondary and micronutrient mixtures. Complex fertilizers-manufacturing of ammonium phosphates, nitro phosphates and NPK complexes. Fertilizer control order. Fertilizer logistics and marketing. Plant bio-pesticides for ecological agriculture, Bio-insect repellents.

**Practical :** Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for the identification of common fertilizers. Identification of anions and cations in fertilizers. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticides available in market. Estimation of nitrogen in urea, water soluble $P_2O_5$ and citrate soluble $P_2O_5$ in single super phosphate, potassium in muraite of potash/ sulphate of potash (by flame photometer), copper in copper oxychloride and sulphur insulphur fungicide- thiram and ziram.

**Chem. 421 General Physical Chemistry** **2+1** **Sem. I**

Liquification of gases. Colloids, preparation and properties, Zeta potential. Emulsions. Adsorption and adsorption isotherms. Applications of colloids and adsorption. Macromolecules, types and molecular weight determination. Chemical and ionic equilibria, acids, bases, pH, buffer solutions and Handerson equation. Salt hydrolysis and calculation of hydrolysis constant and pH of various types of salts. Solubility product, ionic product and concept of precipitation and its applications. Theories of indicators. Photochemistry, Norrish-I, Norrish-II, Florescence, Phosphorescence, concept of singlet and triplet oxygen and Jablonski diagram. Introduction to Infra Red, UltraViolet-Visible, Raman, Nuclear Magnetic Resonace spectroscopy and Flame photometry.

**Practical :** Verification of adsorptions, isotherms, charge on colloidal particles, molecular weight of polymers, preparation of buffer solutions, determination of pKa. Spectrophotometric analysis. Determination $\lambda_0$ . Verification of Oswald's dilution law.

**Chem. 422 Electrochemistry and Surface Chemistry** **3+0** **Sem. II**

Electrolytic conductance and Debye-Huckle theory. Activity coefficient of electrolytes and Debye limiting law. Electrochemical cells. Liquid junction potential. Equilibrium constant and EMF and its determination using different electrodes. Potentiometric titrations, overvoltage and polarography. Adsorption at solid/gas interface, monolayer adsorption. BET equation and its applications. Heat of adsorption. Adsorption from solutions and calculation of surface area of solid from adsorption. Adsorption at liquid/gas interface. Chemisorption and catalysis. Kinetics of surface reactions.

**Chem. 423 General Organic Chemistry** **2+0** **Sem. I**

Introduction to mechanism of various organic reactions including reaction intermediates, carbocations, carbanions, free radicals, carbenes and benzynes. Stereochemistry, optical activity, chirality, compounds with one or more chiral centres, enatiomers, diastereomers, nomenclature and assignment of configurations to simple molecules including RS, EZ, and DL. Conformations of acylic and cyclic systems including staggered, anti, gauche and chair and boat forms. Chemistry of heterocyclic compounds, thiophenes, furan, piperidine, pyridine, pyrrole, pyran. Chemistry of oils, fats and carbohydrates.

**Chem. 424 Radioactivity and Transition elements** **2+0** **Sem. I**

Discussion of f blocks elements, lanthanides, actinides, lanthanide contraction, actinide contraction and its effects, separation of lanthanides and actinides, simple chemistry of elements like Francium, Technetium and Rhenium. Separation of inner transition elements, their salts and uses. Atomic nuclei, binding energy and stability of isotopes. Natural and induced radioactivity, kinetics and half life of radioactive elements, units of radioactivity, Carbon dating, transuranic series. Tracers and their applications. Acid-base concept, hard and soft acids and bases and the application of this concept. Role of transition elements in biological systems.

**Chem. 425 Introduction to Metal Complexes and Chelates** **2+1** **Sem. II**

Metal complexes and metal chelates, Pauling electronegative principle, hydration energy, inter ligand repulsion, weak metal ligand bonding, strong ligand bonding, back bonding and its effect on stability of complexes. Study of charge transfer complexes. Nomenclature and isomerism. Structure and nature of bonding in complexes. Stability and reactivity in metal complexes and factors influencing stability. Substitution reaction and Trans effect. Electronic spectra of metal complexes, magnetic properties of complexes. Role of metal complexes and metal chelates in transportation of micronutrients in plants, role of iron, manganese and copper complexes in plants and animals.

**Practical :** Spectrophotometry, pH metric studies in relation to stability constants of metal ligand systems.

**Chem. 426 Chemistry of Non-transition Elements** **2+0** **Sem. I**

Organometallic compounds of magnesium and copper and their synthetic utility, Latimer and Volt-equivalent diagrams, silicates, iso and heteropolyacids, boron hydride and related compounds, boron halides/sulfurnitrogen cyclic compounds. Phosphates, oxy acids of nitrogen, phosphorous and sulfur

and trends in their acidity and reduction potential, Ellingham diagram, Use of compounds of selenium and their toxicity. Xenon compounds, oxy and flouro derivatives of xenon, their synthesis and chemical reactions structure of silicates and borates.

**Chem. 427 Spectroscopy and Structure Elucidation** **2+0** **Sem. II**

General introduction to principles and theory of various spectroscopic techniques, Infrared (IR) spectroscopy, group absorption, sampling techniques and interpretation of spectra. Nuclear magnetic resonance (1 H NMR and13C NMR), Continuous wave (CW) and Pulsed Fourier Transform (FT) spectrometry, Chemical shift, Spin coupling, Chemical shift equivalence, Coupling constant, and Relaxation time. Difference in CW and FT techniques. Solvent shift and lanthanide shift studies. Theory and application of Ultraviolet spectroscopy, chromophore, auxochrome and red and blue shift, Study of Woodward rules and calculation max of highly conjugated compounds like carotene and lycopene. Mass spectrometry, molecular ion peak, base peak, fragmentation pattern of simple molecules, hydrocarbons, alcohols, ethers alicyclic and cyclic ketones, aldehydes and McLafferty rearrangement. Combined use of spectroscopy for structural elucidation of simple organic compounds.

**Chem. 428 Experiments in Chemistry** **0+3** **Sem. II**

**Practical** : Use of viscosity and surface tension to determine composition of two liquids and molecular weight of high polymer by viscosity, Use of Stalagmometer. Determination of distribution coefficient of iodine between carbon tetrachloride and water. Water equivalent of Dewar's flask and neutralization of hydrochloric acid. Conductometric titration of strong acid with strong base, strong acid with weak base, weak acid with strong base and weak acid with weak base. Solubility of lead sulfate in water and adsorption of acetic acid by activated charcoal. Detection of elements (N, S and halogens) and functional groups (- COOH, -$CONH_2$ , C= O, -CHO, -$NH_2$ and aromatic - OH). Identification of simple organic compounds and preparation of their derivatives. Preparation of tribromophenol, benzillic acid, acetanilide, acetamide, mdinitrobenzene, benzoic acid and oxalic acid and isolation of caffeine. Estimation of phenol and aniline by bromide-bromate and acetylation methods. Equivalent weight of an acid by neutralization method.

**Chem. 429 Drugs, Bimolecules and Polymers** **3+0** **Sem. II**

Classification, preparation, uses and mechanism of action of antipyretic and analgesics, sulfa-drugs, antimalarials and some trivial and modern antibiotics. General introduction to simple terpenes (occurrence, isolation, classification and Isoprene rule). Alkaloids, occurrence, importance, general structural features and Hoffmann exhaustive methylation. Structural aspects of sucrose, starch and cellulose. Methods of preparation, physical properties, dipolar nature, chemical reactions and configuration of amino acids. Peptide-linkage, peptide synthesis and structure of polypeptides. General characteristic and secondary structure of proteins. General introduction to polymers, Types of polymers and polymerization process, Polymerization under radical, ionic and coordination and their mechanism. Chemistry of natural and synthetic polymers, synthetic fibers, plastics, foaming agents (plasticizers) and biodegradable polymers.

**Chem. 430 Fundamental Quantum and Solution Chemistry** **3+0** **Sem. II**

Elementary quantum mechanics, Black body radiation, Photoelectric effect, Bohr's model and its drawbacks, de Broglie hypothesis, Heisenberg's uncertainty principle, postulates of quantum mechanics. Schrödinger's wave equation, physical interpretation of wave function, particle in one dimensional box and three dimensional box, Schrödinger's wave equation for H atom, radical distribution function, Quantum numbers, n, l, m and their importance, Eigen value and eigen function, Hamiltonian operator, physical interpretation of wave function. Molecular orbital theory, Formation of molecular orbital by linear combination of atomic orbital, Calculation of energy levels from wave functions, Physical pictures of bonding and antibonding wave function. Colloids, preparation and properties. Zeta potential, emulsion, ionic equilibria, acids and bases, pH, buffer solution and Henderson's equation, salt hydrolysis, solubility product and its application. Adsorption and adsorption isotherms. Applications of adsorption, difference between physical and chemical adsorption.

## Postgraduate Courses

**Chem.-501 Thermodynamics and Electrochemistry 3+0 Sem. I**

**Unit I** Thermodynamic terms, variables, processes, functions

**Unit II** Thermochemical equations, heat of reaction at constant volume and pressure , relation between Cp and Cv, Born Heber Cycle, Bond energies

**Unit III** Partial molar properties and their determination ,Gibbs Duhem equation, Concept of Gibbs and Helmolz free energy, derivation of different relationships of free energy, concept of entropy, different relationships of entropy

**Unit IV** Concept of energy, work and heat, internal energy and enthalpy, mathematical relation for first law, Joule Thomson effect, combined form of first and second law, isothermal and adiabatic expansion of real and ideal gas, Carnot cycle, calculation of entropy change, Nernst heat theorem, determination of absolute entropy, residual entropy

**Unit V** Flux and gradient, Phenomenological equations. Onsagar reciprocal relation, entropy production

**Unit VI** Membrane transport involving biochemical reaction. metabolic and biosynthetic reaction, ATP production during biochemical processes of various types, applications of irreversible thermodynamics in biological processes, coupled reactions

**Unit VII** Role of statistical mechanics, thermodynamic probability, partition function and their relation to thermodynamic quantities

**Unit VIII** Introduction to Fermi–Dirac statistics, Bose–Einstein statistics, Maxwell Boltzmann distribution

**Unit IX** Electrode potential, electrochemical series and its applications, conductometric and potentiometric titrations,reversibleelectrodes,Electrochemical cells Nernst equation, Application of EMF measurements

**Unit X** Factors affecting migration of ions, transport number,Kohlrausch'slawand its applications, Ionic equilibrium,

**Unit XI** Debye-Huckel theory, Debye-Onsager theory of conductance, activities and activity coefficients of electrolytes and their determination, Electro-kinetic and electro capillary phenomena, Theories of electrical double layer at the electrode electrolyte interface

**Unit XII** Over potential, derivation of Butler-Volumer equation. Tafel plots, Polarography, Il-Kovic equation, half wave potential and its significance, Electrochemistry of corrosion and eletrolysis

**Chem.-502/ AC 509 Chromatographic and Spectroscopic Techniques 2+1 Sem I**

**Unit I** Different separation methods, classification of separation methods based on the property resulting in separation,criteria for selection of separation methods

**Unit II** Theory, principle and instrumentation of GC, GC detectors and columns of different types, application of GC in the analysis of organic compounds

**Unit III** Theory, principle and instrumentation of HPLC, LC detectors and columns of different types, mobile phase, application of HPLC in the separation and analysis of organic compounds

**Unit IV** Theory, principle, and instrumentation of absorption (UV, Visible and IR) spectroscopy, application of UV and IR in structure elucidation of organic compounds

**Unit V** Theory, principle and instrumentation of NMR (1H, 13C) spectroscopy, application of NMR spectroscopy in the characterization of organic compounds

**Unit VI** Theory, principal, instrumentation of mass spectrometry, mass fragmentation pattern, application of MS in structure elucidation and confirmation

**Unit VII** Theory, principal, instrumentation of Tandem GC-MS and LC-MS Techniques Tandem chromatographic and spectroscopic techniques (GCMS-MS/LCMS-MS), Application of tandem techniques for confirmation of the chemical structure of the analyte constituents. Raman Spectroscopy, Electron and Mössbauer spectroscopy

**Practical :** Separation of organic compounds mixture by GC and HPLC. Application of UV and IR spectrophotometry for the detection of organic compounds. Identification and structure elucidation of organic compounds by NMR (1H, 13C) and MS.Identification and structure elucidation of organic compounds by GC-MS, LC-MS and MS fragmentation pattern

**Chem.-503 Basic Concepts of Inorganic Chemistry** **2+0** **Sem. I**

**Unit I** Rutherford's model of atom, Photoelectric effect and Planck's quantum theory, Bohr's model of atom, de-Broglie concept, Heisenberg's uncertainity principle

**Unit II** Schrodinger wave equation and its derivation, Quantum numbers, Normal and orthogonal wave functions,wave functions for hydrogen atom, radial distribution curves for s, p, d and f orbitals, angular wave functions for s, p, d and f orbitals-their significance and use. Slater-type orbitals; effective nuclear charge, use of radial distribution curves to explain order of filling of orbitals in many electron systems.

**Unit III** Ionic bond, covalent bond, dative bond, metallic bond.Valence Bond Theory (VBT) and its model, MOT: Linear combination of atomic orbital, overlap integral, coulomb Integral, molecular orbital treatment of $H_2$, bonding and antibonding orbital.Construction of MO and VB functions, MOEL diagrams

**Unit IV** Hybridization, Wave functions for hybrid orbitals, Orientation of hybrid orbitals in space, VSEPR theory, Geometry of molecules containing bond pair of electrons ($BeF_2$, $CH_4$, $SF_6$, $IF_7$), Geometry of molecules containing bond pairs as well as lone pair of electrons ($SnCl_2$, $SF_4$, $XeF_2$, $XeF_4$, $IF_5$), Geometry of some ions ($CO_3^{2-}$, $NO_3^-$, $ClO_4^-$)

**Unit V** Symmetry elements and Symmetry operations (Identity, Axis of Symmetry, Plane of Symmetry, Centre of inversion and Improper axis of rotation, Group and its Characteristic, product of Symmetry operations, symmetry Operations symmetry elements commonly occurring molecules like $NH_3$, $CH_4$, $SF_6$, $PF_5$, $SF_4$, $Ni(CO)_4$, $Fe(CO)_5$ subgroups, similarity transformations and conjugates, equivalent atoms and equivalent symmetry elements.

**Unit VI** Classification of point groups, representation of groups, reducible and irreducible representation

**Unit VII** Great Orthogonality theorem, Character tables and construction of character tables for $C_{2v}$ and $C_{3v}$

**Unit VIII** Chemistry of Photosynthesis: Cyclic and Noncyclic phosphorylation, photosynthetic reaction center (PSI and PSII), detailed mechanism of electron transport reaction involved during dark and light reactions. Metalloenzymes: Definition, Terms: Epoenzymes, prosthetic groups, coenzymes and cofactors. Inhibition and poisoning. Structure and function of specific metalloenzymes: Carbonic anhydrase, carboxypeptidae, catalase, peroxidase, superoxidase dismutase (SOD) and cytochrome P450.

**Unit IX** Natural oxygen carriers: Iron storage and transport ferritin, transferrin, bacterial iron transport, hemoglobin and myoglobin, nature of heme-dioxygen binding, model systems, cooperativity, Bohr 's effect in hemoglobin, hemerythrins. Non-heme oxygen carriers: hemocyanin. Iron sulfur proteins**:** Ferrodoxin and rubredoxin

**Unit X** Biological Nitrogen fixation: General and specific structural features of Nitrogen fixation, Mode of action of Nitogenase, Role of important metal ions in biological system:Role of vanadium, chromium, nickel tungsten and molybdenum metal ions, chelates in chemotherapy, lithium and mental health, metal complexes as anti-tumor agents, Chelation therapy.

**Chem.-504 Physical Organic Chemistry** **2+0** **Sem. I**

**Unit I** Concept of isomerism. Classification of isomerism.

**Unit II** Elements of symmetry, molecular chirality, enantiomers, stereogeniccenter,optical activity, properties of enantiomers, Chiral and achiral molecules with two stereogeniccenters, diastereomers, threo and erythro diastereomers, meso compounds, resolution ofenatiomers, inversion, retention and racemization.Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

**Unit III** Determination of configuration of geometric isomers. E & Z system ofnomenclature, geometric isomerism in oximes and alicyclic compounds.

**Unit IV** Conformational analysis of ethane and n-butane; conformations ofcyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexanederivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae.Difference between configuration and conformation.Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity,steric strain due to unavoidable crowding. chirality, methods of resolution, optical purity. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

**Unit V** Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3- butadiene, 1,3,5- hexatriene and allyl system

**Unit VI** Classification of pericyclic reactions. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatorymotions, 4n, 4n+2 and allyl systems. Cycloadddition– antarafacial and suprafacial additions,4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropicreactions.

**Unit VII** Suprafacial and antarafacial shifts of H, sigmatropicshiftsinvolving carbon moieties, 3,3- and – sigmatropic rearrangements. Claisen, Cope and aza-Cope rearreangements. Fluxional tautomerism. Ene reaction.

**Unit VIII** Aromaticity in benzenoid and non-benzenoid compounds, Huckel's rule, annulenes, anti-aromaticity

**Unit IX** Structure and Reactivity**,**Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenesand nitrenes.

**Unit X** The $SN_2$, $SN_1$, mixed $SN_1$ and $SN_2$ and SET mechanisms.The neighbouring group mechanism, neighbouring group participation by π and σ bonds,anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl system, The SNimechanisum.Nucleophilic substitution at an allylicand a vinylic carbon.Reactivity effects of substrate structure, attacking nucleophile, leaving group and reactionmedium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

**Unit XI** Bimolecular mechanisms- SE2 and SE1 mechanism, electrophilic substitutionaccompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarityon the reactivity.

**Unit XII** The SNAr, Ar SN1, benzyne mechanisms, Reactivity – effect of substrate structure, leavinggroup and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smilesrearrangements.

Unit 6: Stereochemistry of elimination reactions E1, E2 E1cB mechanism, competition between elimination and substitution, Anti and syn E2 eliminations, Regioselectivity of elimination reactions, Saytzeff and Hofmann elimination.

**Unit XIII** Mechanisticandstereochemicalaspectsofadditionreactionsinvolvingelectrophiles,nucleophiles and free radicals, regio- and chemoselectivity,orientation and reactivity. Hydrogenation of double bonds, Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

**Chem.-505/AC- 504 NaturalProduct Chemistry 2+1 Sem II**

**Unit I** Chemistry of fats and lipids. Classification, nomenclature, occurrence, isolation, general methods of structure determination and isoprene rule. Structure determination, biosynthesis and synthesis of the following representative molecules: geraniol, citral, α-terpeneol, α-pinene, camphor, abietic acid andβ-carotene.

**Unit II** Alkaloids: Definition, nomenclature, physiological action, occurrence, isolation, general method of structure elucidation, degradation in structure elucidation, classification based on nitrogen heterocyclic ring role of alkaloids in plants. Structure stereochemistry synthesis and biosynthesis of the following: Ephedrine, Cocaine, Nicotine, Atropine, Quinine and Morphine

Steroids: Occurrence, nomenclature basic skeleton. Diel's hydrocarbon and stereochemistry, isolation, structure determination and synthesis of cholesterol,ergosterol, progesterone, testosterone and cortisone. Biosynthesis of Steroids.

Plant Pigments: Isolation and biosynthesis of flavones, flavonoids, isoflavones, chalcones, anthocyanins and Coumarins. General methods of structure determinations and synthesis of Quercetin, Quercetin-3-Glucoside, Cyanidin-7-arabinoside and cyanidine.

**Unit III** Structure, chemistry,properties and function of carbohydrates, amino acids, proteins, andnucleic acids

**Unit IV** Metabolomics definition, Plant and microbial metabolomics, Metabolome analysis (profiling of secondarymetabolites) by GC-MS, LC-MS and NMR spectrometery, Application of metabolomics indifferent fields.

**Unit V** Natural oxidants and their mode of action, Different types of natural oxidants from vegetable, fruit and cereal crops (Examples: carotene, lycopene, betanaine, capsanthins, capsicinoids, anthocyanins, curcuminoids etc.)

**Unit VI** Nutraceuticals and phytoceuticals from microalgae (e.g. phycocyanins), seabuckthorn(phenolics and flavonoids), medicinal plants (boswellic acid, artemisinin, andrographinolides,withanolides, taxol, forskolinetc.) and marine products.

**Unit VII** Different types of natural polymers, Chemistry of natural polymers (Starch, cellulose, Agar,inulin, chitosan, alginate, dextran, guar gum, gum Arabic, gum tragacanthin, xanthan gum,pectin, psyllium etc.). Application of polymers in agrochemical, food and other industries.

**Unit VIII** Major classes of enzymes, Enzymes in food industry, industrial enzymes and their applicationin pharma, leather, textile, detergent and other industries

**Practical :** Extraction of essential oil from mint leaves, lemon and orange peel etc. Extraction and purification of bioactive natural products like lycopene, from tomato orwatermelon. Extraction and purification of curcuminoids from turmeric rhizome. Extraction and purification of anthocyanins from black carrot, purple cabbage, grapes or jamunetc. Extraction and purification of bioactive natural products namely capsanthin and capsaicinoids from chili/paprika. Identification and characterization of the phytochemicals by GC-MS/LC-MS

**Chem.-506 Experiments in Physical Chemistry Practical** **0+2** **Sem II**

**Practical :** To prepare standardized solutions. To determine the neutralization point of acid-base and strength of solution,the composition of a mixture of acetic acid and hydrochloric acid by the conductance measurements. To determine the equivalent conductance of a strong electrolyte at several concentrations, of a weak electrolyte at infinite dilution and verifyOnsagar'sequation and Kohlrausch law respectively. To determine the solubility of salt by conductance measurement. Titrations of acids and basesusing glasselectrode. To determine strength of unknown solution of HCl titrating it with NaOH solution using pH meter. To determine λmax of 1% $CuSO_4$ solution using single beam UV Spectrophotometer. To determine the molar extinction coefficient and verification of additivity of optical density. To determine concentration of given solution spectrophotometrically. To study the complex ion formation by Job's method.

To determine the concentration of metal ions in various samples by Flame photometery AAS and ICAP analyses. To determine the molecular weight of non-volatile substance (glucose, urea, etc.) cryoscopically using water as the solvent and molecular weight of the given substance (glucose, urea etc.) by ebullioscopy. To separate a mixture of potassium permanganate and potassium dichromate by column chromatography. To find Rf value and identify amino acids present in a given mixture with the help of thin layer chromatography. Investigate the adsorption of acetic acid, oxalic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Langmuir adsorption isotherm. To determine the specific rotation of given solution. To determine the refractive index of given liquids and some common reagents by Abbe's refractometer and find the specific and molar refraction.

To determine the percentage composition of given liquid mixture by refractometer. Calculate value of the atomic refraction of C, H and Cl. To determine the electron polarisation and electron polarisability of a liquid refractometrically. To determine the rate constant of hydrolysis of an ester such as methyl acetate catalysed by an acid, say 0.5 M HCl and also the activation of the reaction. Determination of surface tension of given liquid by drop number method by stalagmometer. To compare cleansing action of two different detergents by surface tension method. To determine coefficient of viscosity of given liquid by Ostwald's viscometer and molecular weight of polymer by viscosity measurements.

**Chem.-507 Quantum Chemistry-Statistical Mechanics 3+0 Sem. I**

**Unit I** The failure of classical physics, Rutherford's model, photoelectric effect, Bohr model, hydrogen spectrum.

**Unit II** Introduction to quantum mechanics, Wave-particle duality, The Schrodinger equation, The Born interpretation of the wavefunction, Information in a wavefunction, The uncertainty principle, Postulates of quantum mechanics.

**Unit III** A particle in a box, Motion in two and more dimensions, Tunnelling, Impact on nanoscience: scanning probe microscopy, The energy levels and wavefunctions, Rotation in two dimensions: a particle on a ring, Rotation in three dimensions: the particle on a sphere, Impact on nanoscience: Quantum dots, Spin.

**Unit IV** Time independent perturbation theory, time dependent perturbation theory.

**Unit V** The structure of hydrogenic atoms, Atomic orbitals and their energies, Spectroscopic transitions and selection rules.

**Unit VI** The orbital approximation, Self-consistent field orbitals, Quantum defects and ionization limits, Singlet and triplet states, Spin-orbit coupling, Term symbols and selection rules.

**Unit VII** Born-Oppenheimer approximation, Valence bond theory of homonuclear diatomic and polyatomic molecules.

**Unit VIII** Molecular orbital theory of hydrogen ion, homonuclear and heteronuclear diatomic molecules, The Huckel approximation, Prediction of molecular properties.

**Unit IX** Introduction to Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics.

**Unit X** Molecular, translational, rotational, vibrational, electronic and partition functions for an ideal gas, thermodynamic properties in terms of partition function, Ideal Bose-Einstein gas: Bose-Einstein distribution and condensation, Ideal Fermi-Dirac gas: Fermi-Dirac distribution and thermodynamic properties.

**Chem.-508 Chemical Kinetics and Surface Chemistry 2+0 Sem. II**

**Unit I** Rate equation, order of a reaction, integration of rate expressions, half-life time, methods for determining order of reaction, steady state approximation, effect of temperature on reaction rates, Arrhenius equation.

**Unit II** Collision theory, transition state theory, comparison of collison and transition state theory, theory of unimolecular reactions, Lindemann's mechanism

**Unit III** Relaxations, stop-flow and flash photolysis techniques, mechanism of free radical reactions, hydrogen-bromine reaction, photochemical decomposition, polymerization, explosion, ionic reactions. Complex reactions-electron transfer reactions, consecutive, opposing reactions, kinetics of catalytic reactions.

**Unit IV** Acid base catalysis, effect of pH, salt effects, enzyme catalysis, factors affecting enzyme catalysis, Michaelis-Menten equation

**Unit V** Types of adsorption factors affecting adsorption, Freundlich, Langmuir and BET adsorption isotherm, parameters of isotherms and their significance, linear and non linear modelling, chemical sorption, application of adsorption.

**Unit VI** Heterogeneous catalysis, surface catalyzed reactions, retarded surface reactions, temporary and permanent catalytic poisons, modelling of kinetic data using pseudo first order, second order Elovich and intraparticle model, activation energy for surface reactions.

**Chem.-509 Co-ordinate Chemistry, Reaction Mechanism and Inorganic Polymers 2+1 Sem. I**

**Unit I** Introduction, definition of terms-complex ion and coordination number, different types of ligands, Werner's coordination theory, nomenclature, structural, geometrical and optical isomerism in complexes of coordination number 4 and 6.

**Unit II** Postulates of valence bond theory, shortcomings, electroneutrality, EAN rule, back-bonding.

**Unit III** Crystal field splitting in octahedral, tetrahedral and square planar complexes, Crystal field stabalization energy, Colour of complexes, Magnetic properties: paramagnetic and diamagnetic complexes.

**Unit IV** Structural effects of crystal field splitting (ionic radii, John-Teller effect), Thermodynamical effects of crystal field splitting (hydration, ligation and lattice energies) Factors affecting the magnitude of crystal field splitting, ionic radii, Jahn-Teller distortion, Thermodynamical effects of crystal field splitting (hydration, ligation and lattice energies).

**Unit V** Limitations of Crystal field theory, introduction of ligand field theory, evidence of covalent bonding in metal ligand bonds.

**Unit VI** Molecular orbital picture of square planar, tetrahedral and octahedral coordination complexes having sigma bonding ligands, pi-donor ligands.

**Unit VII** Molecular orbital picture of square planar, tetrahedral and octahedral coordination complexes having pi acceptor ligands.

**Unit VIII** Concept of stability, liability, inertness, thermodynamic stability, kinetic stability, EAN, chelation, stability constant.

**Unit IX** Factors affecting the stability, determination of stability constant from thermodynamic data, Irving William series.

**Unit X** Introduction to atomic spectroscopy, orbital and spin angular momentum, spin-spin coupling, spin-orbital coupling, the energy terms, coupling schemes, Russel-Saunder's coupling scheme, J-J coupling, Selection and relaxation rules, term symbols.

**Unit XI** Orgel diagrams, application of orgel diagrams to electronic spectra of transition metal complexes, charge transfer spectra, spectrochemical series, Tanabe Sugano diagrams.

**Unit XII** Substitution reactions in octahedral complexes and associated stereochemical changes, redox reactions in coordination compounds and their mechanism. Acid and Base hydrolysis of octahedral complexes, $S_N^1$, $S_N^2$ mechanism, mechanism of acid hydrolysis of octahedral complexes with/without pi bonding ligand, mechanism of base hydrolysis, $S_N^1$(CB) mechanism, Oxidation reduction reactions through atom/group transfer, electron transfer, mechanism of electron transfer reactions in solution phase, outer sphere mechanism, inner sphere mechanism. Substitution reactions, mechanism in square planar complexes, trans effect, theories of trans effect.

**Unit XII** Substitution reactions, mechanism in square planar complexes, trans effect, theories of trans effect.

**Unit XIII** Introduction, properties, glass transition temperature, Phosphorus based polymers, phosphorus-based chain polymers, Mudderell's salts, Kuroll's salts, phosphorus based network polymers, sulphur, boron and silicon-based polymers.

**Practical :** Preparation of inorganic complexes like $Co[Hg(SCN)_4]$, $Hg[Co(SCN)_4]$, $[Co(NH_3)_5NO_2]Cl_2$, $Co(NH_3)_5\ Cl]Cl_2$, $[Cu(Gly)_2]$, $K_2[Cu(C_2O_4)_2\ ]$, $[Co(acac)_3]$, $K_4\ [Co_2(C_2O_4)_4(OH)_2]$, $[Co(NH_3)_4]SO_4$ and $Na_3[Co(NO_2)_6]$. Determination of stoichiometry and stability of complexes. Complexometric titrations.

**Chem.-510 Synthesis and Characterization of Organic Compounds 0+2 Sem. II**

**Practical :** Separation and identification of the components of a binary organic mixture like phenols/ carboxylic acids, ketones/aldehydes, carbohydrates, aromatic amines, amides, ureas and anilides, aromatic hydrocarbons and their halo- derivatives. Synthesis of 2-phenylindole using Fischer Indole synthesis reaction. Acetylation of glucose: Preparation of α-D-glucose pentacetate and β-D-glucose pentacetate. Synthesis of *p*-nitroaniline from acetanilide. Preparation of 1,2-dihydro-1,5-dimethyl-2-phenyl-3*H*-pyrazole-3-one) (antipyrine) and discussion about its pharmacology. Solvent-free Cannizzaro reaction of benzaldehyde. Quantitative analysis of phenol, aniline. Isolation of essential oils from rose, ajwain, mentha and eucalyptus.

**Chem.-511/AC 501 Introduction to Agrochemicals** **2+1 Sem. II**

**Unit I** Definition of pests and pesticides, Synthetic and natural plant protection chemicals – historyand classification, House-hold pesticides, Non-pesticidal agrochemicals like nitrificationinhibitors, chemical hybridizing agents, hydrogels, soil conditioners, and plant growthstimulants, Pesticide toxicity (LD50, LD90, LC50, EC50, I50),Pesticide antidotes. Safetyprecautions in pesticide application, Introduction to integrated pest management (IPM).

**Unit II** Pesticide production and consumption in India and other countries, Pesticide export and import.

**Unit III** History of botanical and biopesticide use, Structure, properties, and use of conventional botanical insecticides - nicotine, pyrethrins, rotenones and neem limonoids. Plant allelochemicals, Biopesticides and bioagents.

**Unit IV** History of synthetic pesticidese, Structure, properties, and uses of insecticides organochlorines, organophosphates, carbamates, synthetic pyrethroids, fungicides (inorganic and organic), nematicides, rodenticides, herbicides, and plant growth regulators (PGR).

**Unit V** Formulation of pesticides- objective and classification, Conventional solid and liquid formulations such as EC, WP, Dust, Granule etc. Physico-chemical properties of formulations.

**Unit VI** Pesticide adjuvants like synergists, stabilizers and surfactants, Pesticide carriers and diluents General methods of preparation of solid and liquid formulations.

**Unit VII** Pesticide residue - definition and significance, Pesticide residues in food commodities and in water, air and in soil environment.

**Unit VIII** Adverse effects of pesticides on human health, soil health, and on non-target organisms.

**Unit IX** Various techniques for disposal of unused, obsolete, and expired pesticides and their solid and liquid formulations, Disposal of pesticide containers.

**Practical :** To determine the different chemical safety/ hazard symbols and to understand different aspects of safe use and handling of the pesticides. To understand the nature and form of commercially available pesticides. To calculate the active ingredient(a.i.) and active ingredient percentage (a.i. %) of the given formulation of pesticide for the given area of the field. Toprepare solid formulations: wettable powder (WP)/granules (G)/WDG/WSG. Preparation and characterization of nanopesticideformulations. To collect, store and prepare samples for pesticide residue analysis. To identify different types of fertilizers. To determine the nitrogen content in a given sample of diammonium phosphate fertilizer.

**Chem.-512 Reaction, Reagents and Photochemistry** **3+0 Sem. II**

**Unit I** Knoevenagel, Claisen, Deckmann,Mannich, Benzoin, Perkin and Stobbe reactions, Wurtz reaction, Kolbe reaction, Corey-House reaction, Birch reduction,Michael,Gatterman synthesis, Hauben-Hoesch reaction, Laderer-Manasse reaction and Reimen-Tiemannreaction,Reformatskyreaction,Wiliam son ether synthesis, Clemmensen,Wolff-Kishner, Mannich reaction. Baeyer-Villiger oxidation of ketones, Cannizzaro reaction. Meerwein-Ponndorf-Verley reaction, Acetoacetic, Malonic ester and Grignard synthesis. Arndt Eistert, Wittig reactions, Aldol condensation, Hofmann reaction.

**Unit II** Nature of migration, migratory aptitude, memory effects.

**Unit III** Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber,Beckmann, Hofman, Curtius, Schmidt, Shapiro reaction, Fries rearrangement, Claisen rearrangement of allyl aryl ethers, Benzidine rearrangements.

**Unit IV** Reagents in Organic synthesis: Cu, Zn, Mg, Li, $ZnCl_2$ $AlCl_3Al(OR)_3$, $LiAlH_4$, Na, RONa, Ni, $SeO_2$, $BX_3$, $NaBH_4$, $CH_2N_2$,Leadtetraacetate, $HIO_4$.

**Unit V** Importance of photochemistry, Laws of photochemistry, photochemical energy, electronic excitation, excited states, modes of dissipation of energy, energy transfer, quantum efficiency.

**Unit VI** Alkenes: cis-trans isomerization, sensitized cis-trans isomerization, Schenck mechanism,Hydrogen abstraction and addition reactions of olefins, dimerization of olefins and dienes, rearrangement in olefinic systems. Carbonyl compounds: Norrish type I and Norrish type II fragmentation, elimination reactions, deconjugation reaction, other hydrogen transfer reactions, oxetane

formation. excited states of enones, hydrogen abstraction reactions of enones, cyclohexanone and cyclohexadienones rearrangements, Aromatic compounds: Excited state transformations of benzene, addition reactions, photosubstitution reactions.

**Unit VII** Photo-fries reaction of aryl ester and anilides, Barton reaction, photochemical formation of smog, photodegradation of polymers.

**Chem.-513 Chemistry of Transition Metals** **2+0** **Sem. I**

**Unit I** Transition elements-Hund's rule and spectroscopic energy states, magnetism in transition metal, elements of second and third row transition series, chemistry of iso- and heteropolyacids and anions of Mo and W.

**Unit II** The metal-metal bonds, Different physical and chemical properties of compounds with two centered metal-metal bonds; metal clusters, occurrence, electronic structure, oxidation states and stereo chemistry.

**Unit III** Magnetic and spectral properties of lanthanides and actinides, lanthanides contraction, separation of lanthanides and actinides. Chemistry of rare elements francium, technitium, rhenium.

**Unit IV** Organo-transition complexes: Applications in catalysis , reactions, Reduction of CO, synthesis of oxygenated compounds, carbonylation reactions; Monsanto acetic acid synthesis, Eastman acetic anhydride synthesis, Cativa process, Reductive carbonylation, decarbonylation.

**Unit V** Metathesis of olefins, alkene, cycloalkenes, acyclic dienes, olefin cross metathesis, metathesis of alkynes, Use of catalyst for oxygen transfer reaction from peroxo and oxo complexes. Use of Cu (I) catalyst for alkyne-azidecycloaddition reaction.

**Chem.-514 General Physical and Colloidal Chemistry** **3+0** **Sem. I**

**Unit I** Heat changes at constant pressure and constant volume, Heat capacity, Molar and specific heat capacity, Relationship between $C_p$ and $C_v$. Determination of enthalpy change, Bond energies, Hess law and Kirchoff`s equation.

**Unit II** Chemical equilibrium, Equilibrium constant, Relation between Kp and Kc, thermodynamic derivation of law of chemical equilibrium, Factors affecting chemical equilibrium,Applications of VantHoff equation, Homogeneous and heterogeneous equilibrium, Le Chatliers Principle.

**Unit III** Electrochemistry, phenomena of electrolysis, conductance of electrolytes, theory of electrolytes, migration of ions and transport number, Determination of transport numbers by Hittroff method and moving boundary method.

**Unit IV** EMF of cell, Determination of EMF, Electrochemical series, Combination glass electrode, pH measurement by indicatory and electrometric methods.

**Unit V** Control and utility of pH in textile wet processing. Electrochemical theory of corrosion, factors affecting and methods of prevention.

**Unit VI** Methods of preparation and properties of colloidal systems, Classification of colloids, electric and electro kinetic properties , interfacial phenomena, micelle formation, micro and macro emulsions, Importance and applications of colloids.

**Chem.- 515/AC 505 Agrochemical regulation, quality control and management** **2+0** **Sem II**

**Unit I** Provisions of the Insecticides Act 1968 and Insecticides Rules 1971, Schedule of the Insecticide Act. Directorate of Plant Protection, Quarantine & Storage (DPPQ&S), Central Insecticide Board and Registration Committee (CIB&RC), Guidelines for production and use of pesticides.

**Unit II** Provisions of the Food Safety and Standard Act (2006) & rules (2011), Acts relating to protection of air, water and the general environment.

**Unit III** Requirement of data (Chemistry, Bioefficacy, Residue, Toxicology, Packaging etc) for pesticide registration in the country, Guidelines for pesticide export and import, Current status of registered, restricted, and banned pesticides in India.

**Unit IV** Definition of GAP and GLP, National and international guidelines for GAP, and GLP.

**Unit V** WHO/FAO Joint Meeting on Pesticide Residues (JMPR), Codex Alimentarius Commission (CAC) EU and EPA guidelines for food safety, Sanitary and phytosanitary (SPS) measures and food safety 19.

**Unit VI** Spurious/ fake pesticides and pesticide formulations, Quality Assurance (QA) and Quality Control (QC) Quality control procedures for pesticide residue analysis, Problems related to pesticide residue analysis in a regulatory laboratory.

**Unit VII** Accreditation and its importance, General criteria for accreditation of chemical and food laboratories, Introduction to ISO/IEC 17025. NABL and GLP compliance of laboratories, Role of International Laboratory Accreditation Cooperation (ILAC) and Asia Pacific Laboratory Accreditation Cooperation (APLAC) in promoting accreditation recognition arrangements (MRAs) and practices.

**PGS-504 Basic Concepts in Laboratory Techniques** **0+1 Sem. I & II**

**Practical** : Safety measures while working in lab. Handling of chemical substances. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets. Washing, drying and sterilization of glassware and drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution. Handling techniques of solutions. Preparation of different agro-chemical doses in field and pot applications. Preparation of solutions of acids and neutralisation of acid and bases. Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath. Electric wiring and earthing. Preparation of media and methods of sterilization. Seed viability testing, testing of pollen viability and tissue culture of crop plants. Description of flowering plants in botanical terms in relation to taxonomy.

**Chem.-591 Seminar** **1+0**

**Chem.-599 Master's Research** **0+30**

## Ph.D. courses

**Chem.-601 Special Topics in Chemistry** **3+0 Sem. II**

**Unit I** Benzenoid and non-benzenoid compounds – generation and reactions.

**Unit II** Alcohol, amine, carbonyl, carboxylic acid, phosphate and terminal alkyne protecting groups.

**Unit III** Introduction, need of remote functionalization, synthetic methodology, radical centred mechanism, enzymatic C-H bond activation, metal catalysis.

**Unit IV** Introduction, importance, mono, bis and tris annulation, Robinson annulation, drawbacks.

**Unit V** Recent oxidative and reductive techniques and their use in organic synthesis, Oxidation of hydrocarbons, alcohols and ketones, catalytic hydrogenation, reduction by dissolving metals, reduction by hydride transfer, enzyme catalysed reduction, Wolff-Kishner reduction, reduction with diimide and trialkylsilanes.

**Unit VI** Synthesis backwards, disconnections, synthons, multiple step syntheses, functional group interconversions, C-C disconnections, available starting materials, donor and acceptor synthons, two group C-C disconnections, 1,5 related functional groups, natural reactivity and umpolung.

**Unit VII** Chiral pool, resolution of two enantiomers, chiral auxiliaries, chiral reagents, asymmetric catalysis, asymmetric formation of C-C bond, asymmetric aldol reaction.

**Unit VIII** Prochirality, diastereoselective additions to carbonyl groups, stereoselective reactions of acyclic alkenes, stereoselective aldol reaction, single enantiomers from diastereoselective reactions.

**Unit IX** Stereochemical control in six membered rings, stereoselectivity in bicyclic compounds, reactions with cyclic intermediates.

**Unit X** Concept of symmetry in molecules, symmetry elements, molecular point groups in low and high symmetry, molecules of special symmetry, notation of point groups, systematic assignment of point groups, groups, subgroups, classes, group multiplication tables, matrix representation of symmetry elements

and point groups, character tables, reducible and irreducible representations, Mulliken symbolism rules, standard reduction formula, the direct product.

**Unit XI** Symmetry of normal modes of molecules, IR and Raman active modes.

**Unit XII** Alkene hydrogenation, Tolman catalytic loops, Synthesis gas, hydroformylation, Monsanto acetic acid process, Wacker process, Synthetic Gasoline, immobilized homogeneous catalysts, platinum pop, Stille coupling, Suzuki, Negishi, Hiyama, Sonogashira, Kumada and Heck coupling reactions.

**Unit XIII** Classification of nanomaterials on the basis of material and size, Methods for characterization of nanoparticles, Electron microscopy, X-Ray diffraction, SEM, TEM, ICP-AES and XPS.

**Unit XIV** Supramolecular Chemistry: Concepts, building blocks and applications.

**Chem.-602 Advanced Physical Chemistry** **3+0** **Sem. II**

**Unit I** Unit cell and crystal structures, Bravais Lattice, Miller indices, d-spacing formula, Density of crystals, Close packing cubic and hexagonal, Important structures.

**Unit II** Perfect and imperfect solids, Types of defects, Point, line and area defects, dislocation in solids.

**Unit III** Ionic, Covalent, Metallic, Vander Walls's and hydrogen bonding, Band structure of solids.

**Unit IV** Conductivity, Specific conductivity, Semiconductors, Ionic conductance, Dielectric properties, Pyro electrics, Ferro electrics, Pyzo electrics materials.

**Unit V** Magnetic materials, Cause and consequences of magnetism, Recent applications of magnetic materials.

**Unit VI** Scattering process, Luminescence, Phosphorescence, Photo detectors, Optical fibres, Photovoltaic.

**Unit VII** Difference between X-ray crystallography and X-ray powder pattern, Basic principle and recent applications of XRD, Line broadening, XRD characterization of materials.

**Unit VIII** Principle and applications of Mossbauer spectroscopy for iron and tin compounds.

**Unit IX** Basic principle and applications of ESR.

**Unit X** Basic principle and applications of TG, DTG and DSC techniques.

**Unit XI** Structure and applications of $TiO_2$, ZnO, graphene, MXenes and glasses.

**Unit XII** Structure and recent application of transition metal oxides, graphene, Structure, properties and application of different glasses.

**Chem.-603 Organometallic Chemistry** **3+0** **Sem II**

**Unit I** Organometallic compounds of group 2,12,13,14,15 and transition metals, bonding, aromatic character and reactions of ferrocene, 18 electron rule, concept of isolobality.

**Unit II** Chemistry of boranes- reaction with Lewis bases, electrophilic substitution, synthesis of boron hydrides, carboranesandmetallocarboranes.

**Unit III** Wade's rule, mononuclear metal carbonyls, IR spectra, geometry, bond order of metal carbonyls, difference between terminal and bridging carbonyl group, Carbonyls of Ni, Pd, Pt.

**Unit IV** Synthesis and structure of metal alkyls, metal aryls, metal carbonyls, metal carbenes and metal carbines.

**Unit V** Reaction pathways-association reactions, Substitution reactions, addition and elimination reactions, rearrangement reactions.

**Unit VI** Reduction of CO, synthesis of oxygenated compounds, carbonylation reactions; Monsanto acetic acid synthesis, Eastman acetic anhydride synthesis, Cativa process, Reductive carbonylation, decarbonylation.

**Unit VII** Metathesis of olefins, mechanism, metathesis of alkene using Fischer carbene complexes, Schrock carbene complexes, and main and transition metal complexes with stable N-hetrocyclic carbene ligand. Metathesis of cycloalkenes, metathesis of acyclic dienes, olefin cross metathesis, ring opening and ring closing metathesis, ring opening metathesis polymerization; mechanism and its utility. Metathesis of alkynes; mechanism, enyne metathesis, application of alkynes metathesis, alkyne cross metathesis. Use of catalyst for oxygen transfer reaction from peroxo and oxo complexes. Use of Cu (I) catalyst for alkyne-azide cycloaddition reaction.

**Unit VIII** Introduction, Resonance fluorescence and absorption in nuclei, Mössbauer effect, instrumentation for Mössbauer spectroscopy, hyperfine interactions and Mössbauer parameters (Electric monopole interaction : isomer shift, Electric Quadrupole interaction : quadrupole splitting, Magnetic dipole interaction : magnetic splitting). Mössbauer spectra of Fe-57 and Sn-119, Chemical applications of Mossbauer spectroscop.

**Unit IX** Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

**Unit X** Recaptulation of crystal field theory, the free ion, free ion terms, spin-orbit coupling, free ions in week field, effect of cubic crystal on S, P, D, F, G, H and I terms, thermodynamic aspects of crystal fields, crystal field stabilization energy (CFSE), lattice energy and CFSE, free ion terms in medium and strong fields, strong field terms, transition from weak to string field, term energy levels diagrams, Tanabe-Sugano diagrams.

**Unit XI** Molecular orbital theory of complex ions, elementary molecular orbital theory, bonding in octahedral and tetrahedral complexes, electronic spectra of complex ions, selection rules and band widths, spectra of aqueous metal solutions, spectra of spin free and spin paired octahedral 19 complexes, spectra of distorted octahedral and tetrahedral complexes, spetrochemical and nephlauxetic series, charge transfer spectra. Spectral and magnetic properties of square planar, square pyramidal and other complexes.

**Chem.-604 Bio-inorganic Chemistry** **3+0** **Sem I**

**Unit I** Importance of alkali metals, ions and ligands affecting the stability of complexes. Alkali metal ions in the regulation of biochemical events. Transport and storage of metal ions *in vivo.*

**Unit II** Role of metal ions in replication and transcriptions process of nucleic acids. Biochemistry of calcium as hormonal messenger, muscle contraction, blood clotting, neurotransmitter, calcification, metals in the regulation of biochemical events. Transport and storage of metal ions *in vivo.*

**Unit III** Coordinating sites in biologically important ligands such as purines, pyrimidines, nucleosides, nucleotides, structure of DNA and RNA, and their role in biological systems.

**Unit IV** Amino-acids, structure and bonding in peptides,structure of proteins,properties of proteins role of amino acids and proteins.

**Unit V** Haemoglobin and myoglobin as oxygen carriers, Bohr effect. Coordination chemistry of Fe(II) in haemoglobin and oxyhaemoglobin. Relaxed and tense (R & T) configurations of haemoglobin, electronic formulations and mode of bonding of dioxygen in haemoglobin (modeling).

**Unit VI** Cytochromes, hemerythrins and hemocyanins, Ironsulphur proteins and electron transfer agents in biological systems: Systems, synthetic models of 4-ferredoxins, Iron supply and transport in biological systems: Ferritin, transferrin and siderophores.

**Unit VII** Carbonic anhydrase and carboxy peptidase, amino peptidase, Alkaline phosphate. Superoxide dismutase; inhibition of metalloenzymes.

**Unit VIII** Chlorophyll in photosynthesis, current hpothesis for the photo oxidation of chlorophyl, synthetic leaf, 'Z' diagram for electron transport in PS-I and PS-II photosystem. Model studies of WOC and Photosystems.

**Unit IX** Nitrogen fixation: Classification of nitrogen fixing bacteria, Nitrogenase enzymes: EXAFS (Extended X-ray absorption fine structure spectroscopy) for characterization of the cofactor of nitrogenase and its synthetic analogues-double cubane cluster, Vanadium containing nitrogenases, mechanism of nitrogen fixation by nitrogenases and role of ATP in nitrogen fixation, nitrite reductase and nitrate reductase.

**Chem.-605 Organic Synthesis and Spectroscopy 2+1 Sem II**

**Unit I** Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.

**Unit II** Natural abundance of $^{13}C$, $^{19}F$ and $^{31}P$ nuclei; The spinning nucleus, effect of external magnetic field, precessional motion and frequency, Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect; Integrals of protons, proton exchange, spin-spin coupling-splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence, First and second order spectra, $A_2$, AB, AX, $AB_2$, $AX_2$, $A_2B_2$ and $A_2X_2$ spin systems, Simplification of complex spectra (solvent effect, field effect, double resonance), CW and FT NMR, Relaxation processes, $T_1$ and $T_2$ measurements, Applications of PMR in structural elucidation of simple and complex compounds.

**Unit III** Resolution and multiplicity of $^{13}C$ NMR, $^{1}H$-decoupling, noise decoupling, broad band decoupling; Deuterium, fluorine and phosphorus coupling; NOE and origin of nuclear overhauser effect. Off-resonance, proton decoupling, Structural applications of $^{13}C$-NMR, pulse sequences, pulse widths, spins and magnetization vectors, DEPT, INEPT.

**Unit IV** Introduction to 2D-NMR, COSY, NOESY, HSQC spectra.

**Unit V** Role of lanthanide induced shift reagents.

**Unit VI** Harmonic and anharmonic oscillators, absorptions of radiation by molecular vibrations, selection rules, force constant, frequency of vibrational transitions of HCl, vibrations in a polyatomic molecule, 3N-6 and 3N-5 rules, types of vibrations, overtones, combination and difference bands, examples of CO2, SO2 and H2O, Fermi resonance, group vibrations.

**Unit VII** Measurement techniques, Beer – Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Frank Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect, $\sigma$-$\sigma^*$, $\pi$-$\pi^*$, n-$\pi^*$transitions in organic molecules, Woodward rules for conjugated dienes and $\alpha$, $\beta$- unsaturated carbonyl groups, extended conjugation and aromatic sterically hindered systems, Quantitative applications.

**Unit VIII** Introduction, methods of ionization EI & CI, Brief description of LD, FAB, SIMS, FD etc., Ion analysis methods (in brief), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns. Nitrogen rule, determination of molecular ion peak, index of H deficiency, fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketons, esters, amides, nitriles, carboxylic acids ethers, aromatic compounds etc.

**Unit IX** Structure determination of organic compounds by IR, UV-Vis, $^{1}H$ &$^{13}C$ NMR and Mass spectroscopic techniques.

**Practical :** Isolation and characterization of curcumin isolated from turmeric. Solvent free Cannizaro reaction using 2- chlorobenzaldehyde. Synthesis of Benzalacetopenone.

Michael addition of aniline to benzalacetophenone. Epoxidation of benzalacetophenone to its epoxide. NMR study of keto-enol tautomerism in carbonyl compounds. Reduction of 3- nitroacetophenone using i) NaBH4 ii) using Sn and HCl.

Identification of the products with NMR, UV, IR spectra. Study of complex formation using job's method. Monitoring the progress of reaction using TLC and HPTLC. Interpretation of organic compounds using UV-Vis spectroscopy. Identification of different functionalgroups in different organic compounds using IR spectroscopy. Elucidation of the structure of organic compounds using 1H NMR, C13 NMR spectroscopy. Identification and structure elucidation using Mass spectrometry. Identification and structure elucidation using GC-MS/LC-MS. Identifictaion of pesticide residue using GC/HPLC.

**Chem.-606 Constitution of Inorganic Compounds and Dynamics of Inorganic Reactions 3+0 Sem II**

**Unit I** Types of lattices, lattice energy, point groups and space groups, symmetry parameters.

**Unit II** Symmetry of crystals, crystal system, classes of crystals

**Unit III** Introduction to determination of crystal structure by X-ray diffraction, electron diffraction and neutron diffraction techniques.

**Unit IV** Thermodynamics, Laws of thermodynamics, classical thermodynamics, statitstical thermodynamics.

**Unit V** Kinetics and Spontaneity of reaction, Application of kinetics in the prediction of rate of chemical reactions.

**Chem.-60 Green Chemistry** **2+1** **Sem I**

**Unit I** Prevention of waste by products, minimum incorporation of reactants into the final product, minimization of hazardous products, designing safer chemicals, energy requirements for synthesis, selection of appropriate solvent, selection of starting material, use of protecting groups, use of catalyst, product designed should be biodegradable, designing of manufacturing plants, strengthening of analytical techniques.

**Unit II** Choice of starting material, reagents, catalyst and solvents.

**Unit III** Dry cleaning of clothes, versatile bleaching agents, environmental pollution caused by the use of solvents, reagents and products.

**Unit IV** Acidic, basic,oxidation and polymer supported catalyst, Introduction to PTC and applications of PTC in organic synthesis.

**Unit V** Introduction to microwave induced green synthesis, Microwave assisted reactions in water, organic solvents and solvent free reactions. Introduction and applications of ultrasound assisted green synthesis.

**Unit VI** Introduction,biochemical microbial oxidation,reduction reactions, enzymes catalyzed hydrolytic processes.

**Unit VII** Introduction to aqueous phase transformation reactions, oxidation, reduction, polymerization and photochemical reactions,electrochemical synthesis in aqueous phase, Introduction to organic synthesis in solid phase and solid phase organic synthesis without using any solvent.

**Unit VIII** Versatile ionic liquids as green solvents, reactions in acidic and neutral ionic liquids.

**Unit IX** Synthesis of styrene, furfural from biomass, benign synthesis of aromatic amines, neat reaction microwave technology for the synthesis of heterocycles.

**Practical :** Synthesis using agrochemical waste ascatalysts. One pot multicomponent synthesis using microwave. Photocatalysed organic synthesis. One pot multicomponent synthesis using sonicator. Organic synthesis by using water media. Synthesis of organic compounds using solvent less approach. Solid-state synthesis of various compounds. Extraction of essential oil using hydro-distillation methods. Preparation of plant extracts by soxhlet extraction by using water as a solvent.

**Chem.-608/AC601 Agrochemical Formulation Technology** **2+2** **Sem. I**

**Unit I** Solid and liquid formulation, Conventional pesticide formulations such as Dust (D), Granule, pallet (P), Wettable Powder (WP), Emulsifiable Concentrate (EC), and Solution (S). Biopesticide formulations-specifications and types, Limitations of conventional formulations.

**Unit II** Role of adjuvants (carriers, diluents, surfactants, emulsifiers,, dispersing agents, wetting agents, stickers and spreaders, penetrants,safeners, encapsulants etc.), synergists,antioxidants, stabilizers etc. in formulation chemistry.

**Unit III** Physico-chemical properties (solubility, octanol-water partition coefficient, vapor pressure, soil adsorption coefficient, emulsion stability, half-life, shelf-life etc.) and their testing, Formulant-toxicant interactions.

**Unit IV** Water soluble concentrates (WSC), Suspension concentrates (SC), Oil-in-water emulsion (EW), suspo-emulsion (SE), Micro-emulsion (ME), Water soluble bags and packets(WSB/WSP), Oil dispersion (OD), Aqueous flowable (AF).

**Unit V** Water soluble powder, liquid and dispersible granules, Dispersion concentrates, Effervescent tablets, Control/time release formulations. Aerosols, baits, fumigants, and formulations of pesticide mixtures, Seed treatment formulations, Seed dressing.

**Unit VI** Packaging and labeling of pesticide formulations, Machinery and equipment for pesticideformulation, Pesticide application and delivery systems - principles, distribution and coverage.

**Unit VII** Development of nanomaterials – bottom up and top-down approach, nano-sizing of inorganic materials, Techniques for characterization of nanomaterials [Zeta sizer, Dynamic light scattering (DLS), X-ray diffraction (XRD), Scanning electron microscopy (SEM),Transmission electron microscopy (TEM), Atomic force microscopy (AFM), and Scanning tunneling microscopy (STM)].

**Unit VIII** Production and use of nano-enabled pesticide formulation (nanoemulsions, nanodispersions, nanoencapsulation, and other polymer based formulations), Nanocarriers for targeted and controlled release, Benefits and environmental risks of nanopesticides.

**Unit IX** Pesticide residue-concept and toxicological significance, pesticide dynamics in agro ecosystem, biotic and abiotic transformations affecting the fate of pesticides.

**Unit X** Experimental design, sampling, principles of extraction and clean-up from different substrates, Application of ELISA and radiotracer techniques in pesticide residue analysis, new clean up techniques, QUECHERS, ASE (Accelerated solvent extraction);Multi-residue methods, bound and conjugated residues, method validation-linearity, LOD and LOQ, microbial and photochemical degradation, adsorption, leaching in soil.

**Unit XI** Soil, plant and microbial biodiversity,Characteristics and classification of natural resources, management strategies for natural resources.

**Unit XII** Integrated pest management, Essential plant nutrients (major, secondary and minor), organic manures (farm yard, compost, sewagw, sludge, green manure, biogas slurries, etc.), production and manufacture and uses of various nitrogenous, phosphatic, potassic and complex fertilizers and fertilizer mixtures, liquid fertilizers, integrated plant nutrient systems, benefits, disadvantages and environmental toxicity, nitrification inhibitors to enhance nitrogen use efficiency, hydrogels and their application in agriculture, soil conditioners and amendments, toxicity issues.

**Practical :** Study of liquid carriers for the determination of (i) flash point, (ii) specific gravity, (iii) viscosity, and (iv) micelle formation with the surfactants. Study of solid carriers: Determination of (i) Surface acidity by volumetric method, (ii), surface area, (iii) Sorptivity, and (iv)particle size, of the solid carriers. Preparation of solid formulations: wettable powder (WP)/granules (G)/WDG/WSG. Physico-chemical analysis of solid formulations based on BIS/CIPAC/FAO guidelines. Physico-chemical analysis of liquid/ gel formulations based on BIS/CIPAC/FAO guidelines. Preparation of toxicant based insect repellent formulations. Preparation of liquid and gel formulations: EC/SC/SL/OD/EW/gel etc. Preparation and characterization of a nanopesticide formulation. Preparation of controlled release (CR) formulation and the release of active ingredient in soil and water.

**Chem.-691 Seminar I** **1+0**

**Chem.-692 Seminar II** **1+0**

**Chem.-699 Ph.D Research** **0+75**

# ECONOMICS AND SOCIOLOGY

## A. ECONOMICS

### PROGRAMMES

**M.Sc. (Agricultural Economics)**

**Ph.D. (Agricultural Economics)**

### COURSE REQUIREMENTS

**M.Sc.**

| | |
|---|---|
| Fields of specialization | Farm Management, Agricultural Marketing, Agricultural Finance |
| Required courses | AEC-501, AEC-502, AEC-503, AEC-504, AEC-505, AEC-507, AEC-508, AEC-509 |
| Supporting courses | Stat.-502 and the student may choose other supporting courses from the discipline of Statistics/ Computer Science relating to area of special interest and research problem. |
| Minor fields | a. The student may choose at least two courses out of three courses (AEC-506, AEC-510 and AEC-511) as a part of minor courses as these are related to policy advocacy and aim to build larger understanding of the subject.<br>b. The student may opt to choose the remaining minor courses from other disciplines including the disciplines of Agricultural Economics, Agricultural Extension Education, Agri-business Management and are related to the research problem selected by the student. |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

**Ph.D.**

| | |
|---|---|
| Fields of Specialization | Farm Management, Agricultural Marketing, Agricultural Finance |
| Required courses | AEC-601, AEC-602, AEC-603, AEC-604, AEC-605. |
| Supporting courses | RPE-601 and in addition, student may choose supporting courses from subject matter fields (other than minor) relating to special interest and research problem. |
| Minor fields | a. Student may choose at least one course out of the courses (AEC- 606, AEC-607, AEC-608, AEC-609) as a part of the minor courses as these are related to policy advocacy and bring in global prospective with an aim to build a larger understanding of the subject.<br>b. Student may choose the remaining minor courses from the disciplines of Agricultural Economics, Agri-business Management and are related to the research problem selected by the student. |
| Deficiency courses | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**Econ. 51 Elementary Farm Management and Finance** **2+1** **Sem. II**

Farm Management- meaning, scope, importance and relationship with other sciences, Farm management decisions. Characteristics of Punjab farms. Concept of package of practices and its application in terms of cost and returns. Simple planning and budgeting procedure. Farm records. Agricultural finance- nature and significance of agricultural finance. Credit institutions. Capital and credit needs. Classification of farm credit. Use of balance sheet and income statement in credit appraisal. Credit acquisition and repayment schedule.

**Practical** : Preparing farm maps, inventory and farm plan. Maintenance of farm records. Visits to regulated markets, ware houses, co-operative marketing societies and grading laboratories.

**Econ. 52 Marketing of Farm Products** **2+0** **Sem. I**

Marketing- Importance, concepts and definition. Market functions and services. Types of markets. Market functionaries. Method of sale. Market channels, charges and price spread. Market regulation. Market information. Concept and importance of grading and standardization of various food grains, vegetables, fruits and commercial crops at farm and market level. Criteria for formulation of grades. Grade standards adopted by different agencies. Agmarking of honey, flour, ghee, spices, etc. Sampling, analysis, and standard specifications. Role of various marketing agencies and State Government in grading of farm produce.

**Econ. 102 Fundamentals of Agricultural Economics** **2+0** **Sem. II**

Economics- meaning, scope and subject matter and approaches to economic analysis- micro and macro economics, positive and normative analysis, equilibrium analysis. Nature of economic theory- economic methods, laws of Economics, assumptions. Basic concepts- goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics- meaning, characteristics, importance and its role in agricultural planning and economic development of a country. Demand- meaning of demand and its determinants, law of demand, demand schedule and derivation of demand curve, utility analysis of demand, consumer's equilibrium and consumer surplus. Elasticity of demand concept and measurement of price, income and cross elasticity of demand. Production- nature and factors of production, input- output relationship and laws of returns. Cost- cost concepts, short-run and long-run cost curves. Supply- supply concepts, stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply. Market structure- meaning and types of markets, price determination under perfect and imperfect competition in short and long run of firm and industry, shut down and break even points. Distribution theory- meaning, factor market and pricing of factors of production, concepts of rent, wage, interest and profit. National income: meaning, importance, circular flow and accounting of national income, approaches and difficulties in its measurement. Population: population theories, determinants and population control measures. Money- barter system, money supply, general price index, inflation and deflation. Banking- role, types of banks and functions of commercial and central banks and credit creation policy of banking system. Agricultural and public finance- meaning, types and need of agricultural finance, public revenue and public expenditure. Tax- meaning, direct and indirect taxes, agricultural taxation, VAT, GST. Economic systems- concepts of economy and its functions, capitalistic, socialistic and mixed economies, elements of economic planning.

**Econ. 104 Introduction to Agricultural Economics** **2+0** **Sem. II**

Agricultural Economics: Meaning, definition, characteristics of agriculture, Nature and scope of agricultural economics, Distinction between agriculture and industry, Role of agriculture in economic development, Role of government interventions in agricultural development. Planning and Agricultural Development: Meaning and objectives economic planning, benefits of planning, Agricultural development during different Five Year Plans in India, Measures of reorganization of agriculture and NITI Aayog. Factors of

production: Meaning of land and its characteristics, Labor concept, characteristics of labor and efficiency of labor, Capital concept and its characteristics, forms of capital in agriculture and process of capital formation, Organization of business firms, forms of business organizations and their characteristics. Land reforms: Land reforms and Land tenure systems, Concepts of agricultural land holdings in India. Theory of production: Meaning, definition, types of production functions, Laws of Diminishing Marginal Returns and Elasticity of production. Scale of production: Meaning, classification and economies of scale. Theory of costs: Meaning, definitions and different types of costs and their measurement. Revenue concept: Total revenue, average revenue

**Econ. 201 Economics and Marketing** **2+1** **Sem. I**

Economics terms and definitions- Consumption, Demand, Price and Supply. Factors of production. Gross Value Added. Role of Biotechnology/Agriculture sector in national GVA. Marketing- definition, process, need, role and functions. Classification of markets. Various channels of farm produce. Price spread. Marketing efficiency. Constraints in marketing of agricultural produce. Market intelligence: Basic guidelines for preparation of project reports, Bank norms, Insurance, SWOT analysis and Crisis management.

**Practical** : Techno-economic parameters for preparation of projects. Preparation of bankable projects for various biotechnology/ agricultural products and value added products. Identification of marketing channel. Calculation of price spread. Identification of market structure. Visit to different regulated markets, market institutions. Study of SWC, CWC, STC and other processing agencies. Analysis of information of daily prices. Marketed and marketable surplus of different agricultural commodities.

**Econ. 203 Introduction to Economics and Project Evaluation** **2+0** **Sem. I**

Definition and scope of Economics and its relationship with ecology and biology sciences. Basic Economic concepts. Consumption: various types and theories, factors affecting consumption. Production: meaning, forms, production process, various factors of production. Costs: meaning, types, importance. Demand and Supply: meaning, relationship with price, various functions, factors affecting demand and supply. Principles of profit maximization. Market structure: monopoly, perfect competition. Development and environment, project formulation, analysis and evaluation.

**Econ. 204 Agricultural Marketing, Trade and Prices** **2+1** **Sem. II**

Agricultural marketing: concepts, definitions; market structure, marketing mix and market segmentation. Classification and characteristics of agricultural markets. Nature and determinants of demand and supply of farm products. Producer's surplus – meaning, types, marketable and marketed surplus and factors affecting marketable surplus of agri-commodities. Product life cycle (PLC) and competitive strategies. Pricing and promotion strategies and approaches. Market promotion – advertising, personal selling, sales promotion and publicity. Marketing process-concentration, dispersion and equalization; GST and its implications for agriculture, Marketing functions- exchange functions, physical functions and facilitating functions. Market functionaries- types and importance of agencies involved in agricultural marketing; Marketing channels- meaning, definition, number of channel levels and marketing channels for different farm products. Market integration- Meaning, definition and types; marketing efficiency; Marketing costs, margins and price spread-Factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions. Cooperative marketing in India. Risk in marketing-types, speculation & hedging and futures trading. Agricultural prices - meaning, functions and administered prices. Need for agricultural price policy; Trade: concept and need of International Trade, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO: Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

**Practical** : Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies. Identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the

class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Analysis of principles of comparative advantage of international trade.

**Econ. 205 Agricultural Finance and Co-operation** **2+1** **Sem. I**

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit-meaning, definition, need and classification. Credit analysis: 4 R's and 3 C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro finance, KCC, Lead bank scheme and RRBs. Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent development in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports- Bank norms and SWOT analysis. Agricultural Cooperation – meaning, brief history of cooperative development in India, objectives, principles and significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.

**Practical** : Determination of most profitable level of capital use. Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire first-hand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business. Preparation and analysis of balance sheet and income statement. Appraisal of a loan proposal. Preparation of projects for agricultural and value added products.

**Econ. 206 Micro Economics and Macro Economics** **2+1** **Sem. I**

Economics: Definition, scope, importance and subject matter of economics. Basic concepts: Goods-free and economic goods, producer and consumer goods, singleuse and durable use goods and services, wants-types and characteristics, demand, utility-types, value and price, wealth and welfare, capital and income; Micro Economics: Meaning and definitions of micro economics, nature and scope of micro-economics. Theory of Consumer Behavior: Concept and Law of Diminishing Marginal Utility (LDMU). Law of Equi-marginal utility and Consumer's surplus. Indifference curve analysis. Demand concept: Demand function, Law of demand, Elasticity of demand and its measurement. Supply concept: Supply function, Law of supply, Elasticity of supply. Concept of Market Equilibrium. Market structure: Meaning, types and characteristics of market structure. Theory of Firms: Concept and Market Equilibrium under different types of markets. Macro Economics: Meaning and definitions, nature and significance of macro-economics and micromacro-economic paradoxes. National income Meaning and importance, circular flow, concepts of national income accounting and methods of measurement of national income, difficulties in measurement. Concepts of growth and development. Theory of income determination: Classical theory-Say's Law of market, Keynesian theory of income determination-Aggregate demand Consumption, saving and investment functions. Money: Meaning and functions of money, classification of money, money supply. Business cycles: Meaning and phases of business cycles, remedies for control business cycles. Inflation and Employment. Public finance: Meaning of budget, concept of public finance and its components-public revenue and public expenditure, difference between Fiscal and monetary policy, Tax: meaning, direct and indirect taxes, agricultural taxation, VAT and GST.

**Practical :** Law of Diminishing Marginal Utility. Law of equi-marginal utility. Consumer's surplus. Consumer Equilibrium using budget line and indifference curve. Estimation of demand and supply. Derivation of market equilibrium. Elasticity of demand and supply. Price determination under perfect competition. Price determination under monopoly. Price determination under monopolistic competition. National income accounts and their preparation. Derivation of Aggregate Demand and Aggregate Supply curves. Income Determination in Two Sector Model. Income Determination in Three Sector Model. Study of business cycles. Consumption and savings function.

**Econ. 207 Agricultural Finance and Insurance** **2+1** **Sem. I**

Agricultural Finance -meaning, definition, nature and scope. Agricultural Credit -meaning, definition, importance and classification based on various criteria. Credit Analysis - 3 Rs of Credit; 5 Cs of Credit; and 7 Ps of Credit; Repayment Plans. Financial Statements -meaning, types and uses. Ratio Analysis – current ratio, intermediate ratio, net capital ratio, acid-test ratio, debt-equity ratio, operating ratio, fixed ratio and gross ratio. Time Value of Money/Principle of Time Comparison meaning and importance. Compounding and Discounting. History of financing agriculture in India. Nationalization of banks -meaning and objectives; Village Adoption Scheme -origin and objectives; Lead Bank Scheme -origin and functions; Regional Rural Banks -origin, objectives and features; Micro financial Institutions: Joint Liability Groups (JLGs) -meaning and features; Self Help Groups(SHGs)-meaning and features. Scale of finance and security for loans. Banking schemes for agricultural finance -Differential Rate of Interest (DIR) Scheme - origin and features; Kisan Credit Card Scheme -origin, objectives and features. Financial inclusion -Jan Dhan Yojana, financial literacy and business correspondent model. NPAs in agricultural lending: applicability of the SARFESI Act in agricultural lending. Financing Agencies: RBI-activities and functions; NABARD genesis, objectives and functions; AFC-functions; ADB and World Bank- origin and functions; IMF, IFC and IDA. Deposit Insurance and Credit Guarantee Corporation of India (DICGC)-origin and functions. Insurance –meaning and definition. Crop Insurance Scheme -origin, meaning, importance and advantages of crop insurance, Comprehensive Crop Insurance Scheme (CCIS), National Agricultural Insurance Scheme (NAIS), Modified National Agricultural Insurance Scheme (MNAIS), and Weather based Crop Insurance and Fasal Bima Yojana and Unified Package Insurance Scheme (UPIS). Assessment of crop losses, determination of compensation, limitations in application and estimation of crop yields. Livestock insurance - origin, meaning and importance.

**Practical :** Exercises on time value of money - compounding and discounting. Estimation of credit needs for crop and livestock enterprises. Determination of scale of finance for farm enterprises. Repayment plans for short-term loans and term loans. Estimation of risk in crop and livestock enterprises. Estimation of premium amount for insurance. Visits to financial inclusion branch of commercial bank and regional rural bank; and insurance agency in public and private sectors. Visit to weather station.

**Econ. 208 International Trade and Policy in Agriculture** **2+0** **Sem.II**

International Trade - meaning, definition, nature and scope. Salient features of international trade, differences between internal trade and international trade, advantages and disadvantages of international trade. Theories of international trade - mercantilism, theory of absolute cost advantage, theory of comparative cost advantage and modern theory of international trade. Terms of trade - meaning and types. Free trade - meaning, advantages and disadvantages, free trade agreements. Protectionism - meaning, advantages and disadvantages of protectionism, types of protection - tariffs, quotas, subsidies, dumping, cartels and commodity agreements. Balance of Trade (BoT) and Balance of Payments (BoP) - meaning, differences between BoT and BoP, India's BoT and BoP position. Foreign exchange meaning, foreign exchange rate, types of foreign exchange rate, mechanisms of determining foreign exchange rate. Foreign exchange market — meaning and functions, instruments of international payments, foreign exchange control and foreign exchange reserves.WTO –— origin, structure, objectives and functions. Agreement on Agriculture - domestic support, market access and export subsidies. FAO / WHO Codex Alimentarious and SPS measures. Export procedures and documentations, types of export direct export and indirect export, export houses — objectives and types. Agricultural export promotion Organizations - APEDA, MPEDA, Commodity Boards and State Export Promoting Agencies. India's agricultural exports and imports — composition and trading countries. India's foreign trade policy— meaning and objectives.

**Econ. 209 Agricultural Price and Policy Analysis** **2+1** **Sem. II**

Meaning and concepts of agricultural prices: Farm harvest price, wholesale price, retail price, futures and spot prices, producer price, Market prices, administrated prices, price spread. Functions and importance of prices. Sources of price statistics. Estimation of demand for and Supply of agricultural commodities. Price, income, cross price and promotional elasticity of demand and supply. Point and Arc elasticity concepts. Price and output determination under perfect competition, monopolistic competition, oligopoly and monopoly markets. Cobb web models of price quantity determination convergent, divergent and

perpetually oscillating models. Temporal and spatial fluctuations in agricultural prices: types and their causes. Analysis of price movements: estimation of trend, seasonal, cyclical and Irregular movements in prices over time. Analysis of spatial price variations and market integration. Types, construction and uses of price relatives and weighted index numbers. General price level and inflation. Types of inflation. Retail and wholesale price index based inflation measures. Minimum Support Price Scheme and Price Stabilization measures. Commission on Agricultural Costs and Prices (CACP) and State Agricultural Price Commissions. Administered prices of GoI, meaning and Purpose: minimum support prices, levy prices, procurement prices. Factors considered in fixing administered prices. Trends in minimum support prices of food grains, oilseeds, commercial crops and sugarcane. FAQ parameters for produce under MSP policy. Problems in fixation and implementation of minimum support price policy. Procurement centers for implementation of MSP issues of constraints, inadequacy and rejection of produce. New initiative of GoI with respect to support prices. Issues of sugarcane pricing policy of GoI and state government. Market Intervention Schemes of state governments in respect of fruits and vegetables and their performance.

**Practical :** Collection of data on arrivals and prices of agricultural produce from APMCs, Analysis of farm harvest prices, administrated prices for agricultural produce, wholesale prices, Construction of index numbers for prices, Exercises on the Calculation of inflation rate using wholesale and retail price index numbers, Estimation of demand and its forecasting, Analysis of minimum support prices of important agricultural commodities and quantity procured under the scheme. Visits to procurement centers. Analysis of problems faced by procurement centers and farmers under MSP scheme. Analysis of net farm returns from MSP sales and distress sales.

**Econ. 210 Theory and Practices of Banking** **2+0** **Sem. II**

Introduction to Financial markets. Bank - meaning, definition, functions. Types of banking- Commercial, developmental and central. Systems of banking- Unit, branch, holding company, chain. Principles of banking. Credit creation by banks. Development banking institutions. Central banking — Functions. Monetary policy: concept & objectives. Credit control- qualitative and quantitative measures. Bankers' clearing house. Banker - his functions and relationship with customer. Deposit accounts and their operations. Negotiable instruments- bills of exchange, check and bank drafts. Loans and advances and their operations. Securities and modes of charges- lien, mortgage, hypothecation, pledge etc. Investment Banking: Meaning, functions, importance, operational issues. Differentiated Banks: Payment banks, Small Finance Banks, Permitted business. Recent reforms in banking sector in India. Mergers and acquisitions in banking sector, Entry of new generation banks. Banking Ombudsman Scheme, customer service nomination facility, KYC norms and Anti-money laundering policy on KYC.

**Econ. 304 Farm Management, Production and Resource Economics** **1+1** **Sem. II**

Farm management-meaning, concept and objectives. Farms-meaning, types, characteristics, factor determining types and size of farms. Principles of farm management- production function and its type, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Cost- meaning, concept, types and their interrelationship. Importance of cost in managing farm business and estimation of gross farm income, net farm income, family labor income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Farm records and accounts- importance, types , farm inventory, balance sheet, profit and loss accounts. Farm planning and budgeting- meaning, importance, partial and complete budgeting. Steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises. Risk and uncertainty in agriculture production- concept, nature, sources and its management strategies, Crop/livestock/machinery insurance – weather based crop insurance, features, determinants of compensation. Resource economics, externalities in agriculture. Inefficiency, welfare loss and solutions. Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

**Practical** : Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise

combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in India.

**Econ. 305 Market Information and Intelligence** **2+1** **Sem. I**

Market Information-Meaning, Need for Market Information, Merits of Market Information. Importance of Market Information-Types of Market Information. Market Intelligence, Market News and Market Outlook, Essential Characteristics of Good Market Information and Means of Data Collection (Methods). Compilation, Analysis and Dissemination of Market Information and Intelligence in India. Sources of Compilation and Dissemination of Market Information- Institutional and Non –Institutional. Deficiencies, Problems and Reliability of Market Information. Simple Forecasting Tools for Price and Demand Estimation. Time Series Analysis (Trend, Seasonal Indices). Consumer Surveys, Expert Opinion Survey Methods. Market Experiments Methods, Graphical Methods, Smoothing Techniques and Regression Methods. Evaluation of Forecasts.

**Practical** : Price and Demand Analysis of Selected Agricultural Commodities Using Time Series Analysis. Consumers' surveys. Experts' Opinion Survey Methods. Market Experiments Methods. Graphical Methods, Smoothing Techniques. Delphi Method and Regression Methods. Developing market intelligence and information reports.

**Econ. 491 Agro- industrial Attachment** **0+4** **Sem. I**

## Post Graduate Courses

**AEC-501 Micro Economic Theory and Applications** **3+0** **Sem. I**

**Unit I** Basic Concepts- A review: Scarcity and Choice; Production possibility frontier, Positive and normative economics; concepts of opportunity cost, Demand and Supply: determinants of individual demand/supply; demand/supply schedule and demand/supply curve; market versus individual demand/ supply; shifts in the demand/supply curve.

**Unit II** Consumer Choice: Cardinal Utility Approach - Ordinal Utility Approach -Budget sets and Preferences under different situations – Hicks and Slutsky income and substitution effects – Applications of Indifference curve approach - Revealed Preference Hypothesis – Consumer surplus -Derivation of Demand curve – Elasticity of demand- Demand and supply together; how prices allocate resources; controls on prices- price floor and price ceiling – applications in agriculture.

**Unit III** Production and Cost: Production functions; single variable - average and marginal product, variable proportions, stages of production. Two variables - isoquants, returns to scale and to a factor; factor prices; Technical progress; cost minimization and output maximization; Elasticity of substitution. Expansion path and the cost function Concept of economic cost; Short run and long run cost curves; increasing and decreasing cost industries; envelope curve; L-shaped cost curves; economies of scale; revenue and expenditure, elasticity and marginal revenue; Firm equilibrium and profit.

**Unit IV** Market Forms: Behaviour of profit maximizing firms and the production process- Perfect competition: Equilibrium of the market. Long run industry supply, applications: effects of taxes and subsidies; Monopoly: Equilibrium; supply; multiplant firm; monopoly power; deadweight loss; price discrimination; Monopolistic Competition: Product differentiation; equilibrium of the firm in the industry-with entry of new firms and with price competition. Comparison with pure competition. Duoploy: Cournot model and reaction curves; Stackelberg's model, Bertrand model; Oligopoly.

**Unit V** Factor Markets: Labour and land markets - basic concepts (derived demand, productivity of an input, marginal productivity of labour, marginal revenue product); demand for labour; input demand curves; shifts in input demand curves; competitive labour markets; Economic rent and quasi rent.

**AEC-502 Agricultural Production Economics** **1+1** **Sem. I**

**Unit I** Concepts of production economics: Nature, scope and significance of agricultural production economics- Agricultural Production processes, character and dimensions-spatial, temporal - Centrality of

production functions, assumptions of production functions, commonly used forms - Properties, limitations, specification, estimation and interpretation of commonly used production functions.

**Unit II** Factors and theory of production: Factors of production, classification, interdependence, and factor substitution Determination of optimal levels of production and factor application -Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination.

**Unit III** Concepts of cost: Cost functions and cost curves, components, and cost minimization -Duality theory – cost and production functions and its applications -Derivation of firm's input demand and output supply functions -Economies and diseconomies of scale.

**Unit IV** Dynamics of economic assessment: Technology in agricultural production, nature and effects and measurement - Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis- concepts-types and measurement - Nature and sources of risk, modeling and coping strategies.

**Practical :** Different forms of production functions. Specification, estimation and interpretation of production functions. Returns to scale, factor shares. Elasticity of production. Physical optima - economic optima Least cost combination. Optimal product choice. Cost function estimation, interpretation. Estimation of yield gap - incorporation of technology in production functions. Measuring returns to scale - risk analysis.

**AEC- 503 Agricultural Marketing and Price Analysis** **2+1** **Sem. I**

**Unit I** Introduction to agricultural marketing: New Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical coordination.

**Unit II** Aspects of agricultural marketing: Different Forms of marketing: Co-operatives Marketing – APMC Regulated Marketing - Direct marketing, Farmer Producer Companies, e-NAM and marketing under e-NAM, e-marketing Contract farming and Retailing, Organized retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -Performance and Strategies -Market infrastructure needs, performance and Government role - Value Chain Finance.

**Unit III** Future marketing and government: Introduction to Commodities markets and future trading - Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis - Role of Government/SEBI in promoting commodity trading and regulatory measures.

**Unit IV** Use of Information Technology: Role of Information Technology and Market Intelligence in marketing of agricultural commodities, electronic auctions (e-bay), e-Chaupals, Agmarknet and Domestic and Export market Intelligence Cell (DEMIC).

**Unit V** Dynamics of price: Price forecasting – time series analysis – time series models – spectral analysis. Price policy and economic development – non-price instruments.

**Practical :** Supply and demand elasticities in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Marketing structure analysis through concentration ratios. Performance analysis of Regulated market and marketing societies. Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products. Supply Chain Analysis - quantitative estimation of supply chain efficiency. Market Intelligence – Characters, Accessibility, and Availability, Price forecasting. Online searches for market information sources and interpretation of market intelligence reports & commodity outlook. Technical Analysis for important agricultural commodities - Fundamental Analysis for important agricultural commodities - Presentation of the survey results and wrap-up discussion.

**AEC-504 Macro Economics and Policy** **2+0 Sem. I**

**Unit I** Introduction- measurement and concepts: Basic concepts and scope of Macro-economics, National Income Accounting: Methods of measurement of key macro-economic aggregates, relationship of national income and other aggregates (with numerical exercises), real and nominal income

**Unit II** Classical macroeconomics: Say's Law, Quantity Theory of Money, aggregate labour supply and demand of labour, Classical theory of determining output, wages and prices.

**Unit III** Income and spending: keynesian framework Simple Keynesian model of income determination; Keynesian Multiplier- aggregate spending, taxation, transfer payments, foreign spending, balanced budget; budget surplus (with numerical exercises).

**Unit IV** Money, interest and income:Goods market equilibrium-IS curve; Demand for Money, the Liquidity Preference Theory - Liquidity Trap; asset market equilibrium- LM curve; simultaneous equilibrium in goods and asset market- effect of fiscal and monetary policy

**Unit V** Theories of aggregate consumption and investment: Absolute Income Hypothesis, Relative Income Hypothesis, Fisher's Inter-temporal Choice Model, Life-Cycle and Permanent Income Hypotheses; Profits and Accelerator Theory.

**Unit VI** Inflation and unemployment: Inflation- Nature, Effects and control; Types of inflation – demand pull, cost push- stagflation, core inflation, hyperinflation; Phillips curve.

**AEC-505 Econometrics** **2+1 Sem. II**

**Unit I** Introduction: Relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis.

**Unit II** Classical Linear Regression: Basic two variable regression – assumptions estimation and interpretation approaches to estimation – OLS and their properties – extensions to multi-variable models-multiple regression estimation and interpretation.

**Unit III** Breaking down of Classical assumptions: Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches – model misspecification.

**Unit IV** Qualitative variables and simultaneous equation models: Use of dummy variables- Introduction to simultaneous equations- identification problem

**Practical :** Single equation two variable model specification and estimation. Hypothesis testing. Transformations of functional forms and OLS application. Estimation of multiple regression model. Hypothesis testing. Testing and correcting specification errors. Testing and managing Multicollinearity. Estimation of regressions with dummy variables

**AEC-506 Agricultural Development and Policy Analysis** **2+0 Sem. II**

**Unit I** Introduction: Role of agriculture in economic / rural development – Evolution of thinking on agriculture and development ; Agricultural development– meaning, stages and determinants – Population and food supply – need for sound agricultural policies.

**Unit II** Theories of Agricultural Development: Resource exploitation model- Conservation model-Location (Urban impact) model- Diffusion model- High pay-off input model-Induced Innovation Model-Agricultural R&D and Linkages.

**Unit III** Performance of Indian Agriculture Agrarian: structure and land relations; trends in performance and productivity; agrarian structure and technology; credit, commerce and technology; capital formation; subsidies; pricing and procurement; Post Green Revolution agriculture; Production and productivity crisis in agriculture; Regional differences; Food Security, PDS system and Malnutrition.

**Unit IV** Agricultural Policy- Process and Implementation: Instruments of Agricultural Policy; Process of agricultural policy formulation, implementation, Monitoring and Evaluation in India; Global experiences in participatory approach to Agricultural policy process; critical review of various elements of Indian agricultural policy-resource policies – credit policies – input and product marketing policies – price

policies; WTO – Agreement on Agriculture; Planning models. Planning for utilization of resources and Indian Five Year Plans.

**AEC-507 Agricultural Finance and Project Management** **2+1** **Sem. II**

**Unit I** Basic concepts- A Review: Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing – Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's – NGO's, and SHG's.

**Unit II** Credit and its aspects: Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

**Unit III** Financial analysis: Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements – Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

**Unit IV** Project Overview: Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures – B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques – PERT and CPM.

**Unit V** Risk and its Management: Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes – yield loss and weather based insurance and their applications.

**Practical :** Development of Rural Institutional Lending: Branch expansion, demand and supply of institutional agricultural credit and Over dues. Loan waiving- An overview, Rural Lending Programmes of Commercial Banks. Lead Bank Scheme- Preparation of District Credit Plan. Rural Lending Programmes of Co-operative Lending Institutions. Preparation of financial statements using farm/firm level data. Farm credit appraisal techniques and farm financial analysis through financial statements. Performance of Micro Financing Institutions - NGO's and Self-Help Groups, identification and formulation of investment projects. Project appraisal techniques – Undiscounted Measures and their limitations. Project appraisal techniques – Discounted Measures. Network techniques – PERT and CPM for project management. Case Study Analysis of an Agricultural project. Financial Risk and risk management strategies – crop insurance schemes. Financial instruments and methods – E banking, Kisan Cards and core banking.

**AEC-508 Linear Programming** **1+1** **Sem. II**

**Unit I** Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems.

**Unit II** Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farms and non-farm problems as linear programming models and solutions.

**Unit III** Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

**Unit IV** Game Theory- Concepts of game theory, two person constant sum, zero sum game, saddle point, solution to mixed strategies, the rectangular game as Linear Programming.

**Practical :** Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex method. Formulation of the simplex matrices for typical farm situations.

**AEC-509/Soc. 506 Research Methodology for Social Sciences** **1+1** **Sem. I**

**Unit I** Concepts of research methodology: Importance and scope of research in agricultural economics. Types of research – Fundamental vs. Applied. Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.

**Unit II** Hypothesis-Framing and Testing: Hypothesis – meaning – characteristics – types of hypothesis – review of literature – setting of Course Objective and hypotheses – testing of hypothesis.

**Unit III** Sampling: Sampling theory and sampling design – sampling error – methods of sampling – probability and non-probability sampling methods – criteria to choose. Project proposals – contents and scope – different types of projects to meet different needs – trade-off between scope and cost of the study. Research design and techniques – Types of research design.

**Unit IV** Data Collection: Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems – methods of conducting survey – Reconnaissance survey and Pre testing.

**Unit V** Data Analysis: Data coding, tabulation, cleaning. Multivariate analysis –factor analysis' PCA' cluster analysis. Universal procedures for preparation of bibliography – writing of research articles.

**Practical :** Exercises in problem identification. Project proposals – contents and scope. Formulation of Objective and hypotheses. Assessment of data needs – sources of data – methods of collection of data. Methods of sampling – criteria to choose – discussion on sampling under different situations. Scaling Techniques – measurement of scales. Preparation of interview schedule- Field testing. Method of conducting survey. Exercise on coding, editing, tabulation and validation of data. Preparing for data entry into computer. Hypothesis testing – Parametric and Non-Parametric Tests. Exercises on format for Thesis / Report writing. Presentation of the results.

**AEC-510 Indian Economy: History and Contemporary Issues** **2+0** **Sem. I**

**Unit I** India from independence to liberalization: An overview of the economic developments during the period 1947-1980; Objectives and strategies of planned economic development and the role of the State; Sectoral growth performance; savings and investment; Demographic trends and issues; education; health and malnutrition; Trends and policies in poverty; inequality and unemployment.

**Unit II** India since 1980's (liberalization and beyond)- overview: Policy Changes since 1980s.The 1990 Crisis. Causes and Effects of liberalization. Regional differences: infrastructure, primary, secondary and tertiary sector.

**Unit III** Macro trends since 1990: Growth; Savings and Investment, Employment; productivity; diversification; Agro-based industries; competition policy; foreign investment, Regional differences.

**Unit IV** Contemporary issues: Monetary and Financial trends- areas of government spending in India, Capital expenditure, revenue expenditure, plan expenditure, non-plan expenditure, Deficits (fiscal, primary, revenue), impact of fiscal deficit on economy, Capital receipts, revenue receipts, tax and non-tax revenue, direct and indirect taxes, need to rationalize tax structure. Goods and Services Tax (GST). Union Budget, Zero-base budgeting, Gender budgeting, Fiscal devolution and centre-state financial relations in India, WPI, CPI implicit deflators. Foreign Trade policy.

**AEC-511 International Economics** **2+1** **Sem. I**

**Unit I** Concepts of International Economics: Scope and Significance of International Economics - The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium) – Equilibrium in a Simple Open Economy - Possibility of World Trade - Trade gains and Trade Equilibrium.

**Unit II** Barriers to trade: Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.

**Unit III** Models of trade: Ricardian Model of Trade- Specific Factors Model- Heckscher - Ohlin Model - Trade Creation and Trade Diversion – Offer Curve - Export Supply Elasticity and Import Demand Elasticity – Comparative Advantage and Absolute Advantage.

**Unit IV** Rates and Terms of trade: Official Exchange Rate and Shadow Exchange Rate - Walra's Law and Terms of Trade – Trade Blocks. Block 3- Institutions

**Unit V** Trades Institutions: IMF, World Bank, IDA, IFC, ADB – International Trade agreements – Uruguay Round – GATT – WTO.

**Practical :** Producer's Surplus, Consumer's Surplus, National Welfare under Autarky and Free Trade Equilibrium with small and large country assumption. Estimation of Trade Gains. Estimation of competitive and comparative measures like NPC, EPC, ERP and DRC. Estimation of Offer Curve Elasticity, Estimation of Effect of Tariff, Export Subsidy, Producer Subsidy, Import Quota and Export Voluntary Restraints on National Welfare. Estimation of Ricardian Model. Estimation of Effect of Trade under Specific Factor Model Estimation of trade Equilibrium under Heckscher -Ohlin model - Trade Creation and Diversion.

**AEC-512 Institutional Economics** **1+0** **Sem. I**

**Unit I** Basics of Institutional Economics: Old and New Institutional Economics – Institutional Economics Vs Neo- classical Economics. Definition of institutions – Distinction between institutions and organizations – Institutional evolution.

**Unit II** Institutional changes & Resource allocation: Institutional change and economic performance – national and international economic institutions. Transaction cost economics – Transaction costs and the allocation of resources. Transaction costs and efficiency. Asymmetric information – Moral hazard and Principal-Agent problem.

**Unit III** Group and collective Approach: Free rider problem – path dependency – Interlinked transactions. Collective action and the elimination of free-rider problem – The logic of collective action and its role in reducing free rider problem – theory of Groups. Rent seeking – interest groups and policy formulation.

**Unit IV** Property rights: Economic analysis of property rights- property rights regimes – private property – State Property – Common property Resources (CPRs) – public goods and club goods.

**Unit V** Agrarian Institutions: Special features of institutional arrangements in agriculture – Transaction costs in agriculture – Case Studies – Theories of agrarian institutions – tenancy institutions.

**AEC-513 Natural Resource and Environmental Economics** **1+1** **Sem. II**

**Unit I** Basic Foundation: Concepts, Classification and Problems of Natural Resource Economics – Economy Environment interaction – The Material Balance principle, Entropy law-Resources Scarcity – Limits to Growth – Measuring and mitigating natural resource scarcity – Malthusian and Recardian scarcity – scarcity indices – Resource Scarcity and Technical Change.

**Unit II** Theories and economics of natural resources: Theory of optimal extraction renewable resources –economic models of oil extraction- efficiency – time path of prices and extraction – Hotelling's rule, Solow-Harwick's Rule. Theory of optimal extraction exhaustible resources – economic models of forestry and fishery.

**Unit III** Functioning of Market: Efficiency and markets – market failures – externalities – types – property rights – transaction costs – Coase's theorem and its critique – public goods – common property and open access resource management – Collective action.

**Unit IV** Environmental Issues: Environmental perspectives – biocentrism, sustainability, anthropocentrism -Environmental problems and quality of environment – Sources and types of pollution -air, water, solid waste, land degradation – environmental and economic impacts – Economics of pollution control – efficient reduction in environmental pollution.

**Unit V** Regulations: Environmental regulation – economic instruments – pollution charges – Pigovian tax – tradable permits – indirect instruments – environmental legislations in India.

**Unit VI** Sustainability aspects: Concept of sustainable development – Economic Perspective – Indicators of sustainability Relation between development and environment stress-Environmental Kuznet's curve Environmental Accounting – resource accounting methods – International Environmental Issues – climate change – likely impacts mitigation efforts and international treaties.

**Practical ;** Exhaustible resource management –optimum rate of oil extraction. Renewable resource management – optimum harvest of Forestry/fishery. Exercise on pollution abatement –I. Exercise on pollution abatement. Concepts in valuing the environment. Taxonomy of valuation techniques. Productivity

change method. Substitute cost method. Hedonic price method, Travel cost method. Contingent valuation methods. Discount rate in natural resource management. Environment impact assessment Visit to Pollution Control Board.

**AEC-514 Commodity Future Trading** **2+0 Sem. I**

**Unit I** Concepts of commodity future trading: History and Evolution of commodity markets – Terms and concepts: spot, forward and futures Markets – factors influencing spot and future markets. Speculatory mechanism in commodity futures.

**Unit II** Technical aspects: Transaction and settlement – delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets.

**Unit III** Risk and its Management: Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features.

**Unit IV** Commodity Exchange – A review: Important global and Indian commodity exchanges - contracts traded – special features - Regulation of Indian commodity exchanges - FMC and its role.

**Unit V** Analysis of commodity market: Fundamental Vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.

**AEC-515 Development Economics** **2+0 Sem. I**

**Unit I** Conceptions of Development: Development Economics – Scope and Importance - Economic development and economic growth - divergence in concept and approach - Indicators and Measurement of Economic Development – GNP as a measure of economic growth – New Measures of Welfare – NEW and MEW – PQLI – HDI – Green GNP - Criteria for under development – Obstacles to economic development –Economic and Non-Economic factors of economic growth. Development issues, poverty, inequality, unemployment and environmental degradation.

**Unit II** Theories of Economic growth and development: Classical theories- Adam smith - Ricardo-Malthus, Marx's theory of economic development; Schumpeter's theory, Approaches to development-low income equilibrium trap - critical minimum effort- The Strategy of economic development-Balanced vs. Unbalanced growth, choice of technique, investment criteria, big push theory, Rostow's stages of Economic Growth, unlimited supply of labour; social and technological dualisms; roles of capital accumulation, human capital and technological change in economic development, Models of economic growth Harrod-Domar, Kaldor, Mahalanobis, Lewis, FeiRanis, Input-Output, multi-sectoral models.

**Unit III** Comparative Economic Development: Countries selected for case studies -USA, Japan, China and India; Overview of economic development is selected countries; agrarian surplus and the role of the peasantry in economic development; industrial revolution; division of labour, organisation of work and industrial production, the role of the State in developmental transition.

**AEC-516 Rural Marketing** **2+0 Sem. II**

**Unit I** Concept and scope of rural marketing: Concept, Definition and scope of rural marketing, Nature and characteristics of rural markets, Potential of rural markets in India, Rural v/s Urban market.

**Unit II** Environmental factors: Socio-cultural, economic, demographic, technological and other environmental factors affecting rural marketing.

**Unit III** Rural consumer's behavior: Behaviour of rural consumers and farmers, Buyer characteristics and buying behavior.

**Unit IV** Rural Product Strategy: Marketing of consumer durables and non-durable goods and services in the rural markets with special reference to product planning, marketing mix, product mix.

**Unit V** Pricing in rural markets: Pricing policy and pricing strategy, input marketing in rural areas and interlinkages of rural marketing with credit.

**Unit VI** Product promotion and distribution strategy: Media planning, planning of distribution channels and organizing personal selling in rural markets in India.

**AEC-517 Evolution of Economic Thought** **1+0** **Sem. I**

**Unit I** History of economic thought: Absolutist V/s Relativist approaches. Evolution of economic thought V/s economic history. Ancient economic thought: medieval, mercantilism, physiocracy.

**Unit II** Forerunners of classical political economy. Development of classical thoughts (Adam Smith, Robert Malthus and David Ricardo). Critics of classical thoughts: socialist critics. Socialist and Marxian economic ideas. Austrian School of thought.

**Unit III** Origins of formal microeconomic analysis: William Stanley Jevons, Cournot and Dupuit. The birth of neoclassical economic thought: Marshall and Walras. General equilibrium theory. Welfare theory : Keynesian economics.

**Unit IV** The era of globalization: experiences of developing world. Rigidity of the past V/s emerging realism. The changing path of international institutions to economic growth and development approaches.

**Unit V** Economic thought in India: Naoroji and Gokhale. Gandhian Economics. Economic thought of independent India. Nehru's economic philosophy. Experiences of the structural adjustment programmes of the post liberalization era.

**AEC-591 Master's Seminar** **1+0**

**AEC-599 Master's Research** **0+30**

## Ph.D. courses

**AEC-601 Advanced Micro Economic Analysis** **1+1** **Sem. II**

**Unit I** Consumer Theory: Theory of consumer behavior – Duality in consumer theory - expenditure function and indirect utility function - Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumers' Welfare – Consumer's Surplus, Compensating Variation and Equivalent Variation - Dynamic versions of demand functions – Integrability of demand functions. Demand Models – Linear Expenditure System, Almost Ideal Demand System. Applications of consumer theory – Household model and time allocation – Labour supply decisions by households.

**Unit II** Market: Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models – collusive and non-collusive models of oligopoly - Cournot model, Chamberlin model, Stackleberg solution.

**Unit III** General Equilibrium: General equilibrium theory – Conceptual overview - General equilibrium conditions with Production and Consumption. Existence, Uniqueness and Stability of general competitive equilibrium. Walrasian general equilibrium – Mathematical derivation of conditions for general equilibrium.

**Unit IV** Market failure: Market failure - Incomplete markets - Asymmetric information – Principal-Agent problem, adverse selection and moral hazard. Externalities – Network externalities, Public goods – Optimal provision of public goods.

**Unit V** Welfare Economics: Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics, Pareto conditions of maximum welfare – Criteria for social welfare - Social Welfare functions, Social versus Private costs and benefits.

**Practical :** Problems in consumer utility maximization. Estimation of income and substitution effects. Estimation and comparison of Consumer's surplus. Equivalent variation and compensating variation. Estimation of demand models. Derivation and estimation of labour supply equations from household models. Comparative static analysis in consumption. Advanced problem solving in price determination under perfect competition, monopoly, oligopoly and monopolistic competition. Game theory models. Problems solving in General Equilibrium Theory and Welfare Economics. Problems in public goods provision.

**AEC-602 Advanced Macro Economics** **2+0** **Sem. II**

**Unit I** Overview: Conceptual framework - Classical, Keynesian, Neo-Classical, and Neo-Keynesian macroeconomics; Review of Keynes-Classical Synthesis; Aggregate Demand and Supply in the closed economy with fixed and variable price level- determination of wage, prices, output and employment.

**Unit II** Open economy models: Exchange rate determination; purchasing power parity; asset market approach ;Short-run open economy models; Mundell-Fleming model- exchange rate regime: perfect capital mobility under fixed and flexible exchange rate; effectiveness of fiscal policy and monetary policy; Dornbusch's overshooting model; monetary approach to balance of payments; international financial markets

**Unit III** Dynamic Macroeconomic Models: Introduction to dynamic macroeconomic Models; Dynamic aggregate demand and supply – short and long term equilibrium- rational expectations approach.

**Unit IV** Business Cycles: Business cycle and its alternative equilibrium model, Stability analysis Economics of Great Events-Depression, Hyperinflation and Deficits ; Advances in Business Cycle Theory; Real Business Cycles & Neo-Keynesian Economics.

**Unit V** Macroeconomic Polices: Monetary policy - Design of Monetary Policy; Inflation Targeting, Fiscal Policy - Government Budget Constraint: The Arithmetic of Deficits and Debt, Current versus Future Taxes, the Evolution of Debt-to-GDP Ratio ; Public Borrowing-Internal and external aid, Deficit financing, Development Financing; BOP & Adjustment Policies - Foreign Exchange Policy -International macro-economic policies, IMF, IBRD, UNCTAD.

**AEC-603 Advanced Econometrics** **2+1** **Sem. II**

**Unit I** Review: Review of classical regression model – review of hypothesis testing – restrictions on parameters – single equation techniques.

**Unit II** Concept of least squares: Ordinary least squares – weighted least squares - generalized least squares – method of principal components – instrumental variables method - maximum likelihood method - errors in variables, non-linearity and specification tests – non spherical error terms.

**Unit III** Dummy Variable: Dummy variables - Qualitative and truncated dependent variables - limited dependent variables –LPM, probit and logit models, their multinomial extensions.

**Unit IV** Models and their extensions: Autoregressive distributed lag models – panel data fixed and random effects models and their extensions.

**Unit V** Simultaneous equation models: Simultaneous equation methods –identification – estimation by indirect least squares 2SLS, PIML, SURE, 3SLS.

**Practical :** Estimation of multiple regression model. GLS estimation methods. Testing mis-specification errors. Testing and Managing multicollinearity, heteroscedasticity and autocorrelation. Estimation of LPM. Logit and Probit models. Comparing two regressions - Chow test. Estimation of distributed lag models. Panel data random and fixed effects models. Indirect least squares 2SLS, SURE, 3SLS. Estimation of simultaneous equation models.

**AEC-604 Advanced Production Economics** **2+1** **Sem. II**

**Unit I** Production Process: Agricultural Production process – Relationship between farm planning and production economics-scope of agricultural production and planning-methods/procedures in agroeconomic research and planning.

**Unit II** Production Functions and characteristics: Production functions, components, assumptions, properties and their economic interpretation - Concepts of homogeneity, homotheticity,, APP, MPP, elasticities of substitution and their economic relevance – Production relations –optimality-Commonly used functional forms, nature, properties, limitations, estimation and interpretation - linear, Spillman -Cobb Douglas, quadratic, multiplicative (power) functional forms - Translog, and transcendental functional forms -CES, production functional forms Conceptual and empirical issues in specification, estimation and application of production functions- Analytical approaches to economic optimum - Economic optimum – determination of economic optimum with constant and varying input and output prices- Economic optimum with production function analysis - input use behaviour.

**Unit III** Decision Making in Production: Decision making with multiple inputs and outputs – MRT and product relationship-cost of production and adjustment in output prices-single input and multiple product decisions- Multi input, and multi product production decisions - Decision making with no risk -Cost

of wrong decisions - Cost curves – Principles and importance of duality theory - Correspondence of production, cost, and profit functions - Principles and derivation of demand and supply functions

**Unit IV** Technology, Efficiency and Risk Management: Technology, input use and factor shares -effect of technology on input use decomposition analysis-factor shares-estimation methods- Economic efficiency in agricultural production – technical, allocative and economic efficiency – measurement - Yield gaps analysis – concepts and measurement - Risk and uncertainty in agriculture – incorporation of risk and uncertainty in decision making – risk and uncertainty and input use level-risk programming.

**Unit V** Programming: Simulation and programming techniques in agricultural production-Multiple Objective Programming (MOP) – Goal programming, Weighted sum and Compromise programming – applications.

**Practical :** Estimation of different forms of production functions. Optimal input and product choice from estimated functions**.** Derivation of demand and supply functions and estimation. Estimation of cost function and interpretations. Optimal product and input choice under multi input and output system. Estimation of factor shares from empirical functions estimated. Estimating production functions incorporating technology changes: Decomposition analysis and incorporation of technology. Estimation of efficiency measures – Stochastic, probabilistic and deterministic frontier production functions. Risk programming – MOTAD-Quadratic programming. Simulation models for agricultural production decisions- Goal programming – Weighted, lexicographic and fuzzy goal programming-Compromise programming.

**AEC-605 Operations Research** **2+1** **Sem. I**

**Unit I** Concepts: Elementary concepts and objectives of Operations Research, Review of Linear programming - Assumptions & Methods, Non-linear programming problem - Quadratic programming, Multi Objective Programming (MOP)

**Unit II** Inventory- A Review: Inventory control models, costs involved in Inventory management, types of inventory, Economic order quantity model, Waiting line models: Waiting line problem, Characteristics of a waiting line system, Single channel model.

**Unit III** Models: Markov Chains, Sequencing, Replacement models, Transportation and Assignment problems.

**Unit IV** Decision Making: Decision making under risk and uncertainties, decision problem, maximax criterion, maximin criterion, minimax regret criterion, Laplace criterion, Pay off tables, Decision trees, Expected value of perfect information.

**Unit V** Game Theory: Game Theory – Two-person Zero sum game, Simulation, Network Analysis-PERT & CPM.

**Practical :** Linear and Non-linear programming problem. Quadratic programming. Multi-Objective Programming- Goal Programming, Lexicographic, Weighted Sum, Determining economic order quantity, reorder levels of EOQ model. Waiting line problem. Problems on Markov Chains. Sequencing and Replacement models. Formulating and solving transportation type problems. Assignment problems as a special type of transportation problem. Solving deterministic and probabilistic queuing models. Structuring and solving decision trees for optimal decisions. Game theory, Simulation, Developing network (PERT/ CPM) diagrams and determining the critical path.

**AEC-606 Advanced Agricultural Marketing and Price Analysis** **2+1** **Sem. I**

**Unit I** Agricultural Marketing- Insights: Importance of market analysis in the agricultural system – types of marketing-advantages and disadvantages – quantitative estimation -the distinguishing characteristics and role of agricultural prices -data sources for agricultural products and prices – softwares used in market analysis.

**Unit II** Institutions and their functions: Role of various formal institutions in agricultural marketing – and functions – measuring their efficiency – public – private partnership – institutional arrangements. Successful case studies.

**Unit III** Market Dynamics: Multi market estimation, supply response models. Market integration and price transmission – supply / value chain management. GAP analysis. Current trends in information in the changing agrifood system.

**Unit IV** Commodity Marketing: Agricultural commodity marketing -spot and futures- marketing of derivatives-speculation, hedging, swap, arbitrage etc. commodity exchanges – price discovery and risk management in commodity markets-Regulatory mechanism of futures trading.

**Unit V** Models for Analysis: Lag operators and difference equations; stationary and stochastic processes; UNIT roots and cointegration; conditional heteroscedasticity: ARCH and GARCH models -forecast evaluation; methods of forecasting. Price indices and econometric estimation and simulation.

**Practical :** Estimation of demand/ supply forecasting. Supply chain / value chain analysis for different commodities. Commodity models - multi market estimation. Time series analysis. Market integration studies. Price discovery. Price volatility estimation. Commodity price forecasting using econometric softwares.

**AEC-607 Quantitative Development Policy Analysis** **1+1** **Sem. I**

**Unit I** Policy Framework: Policy framework – goals, value, beliefs and welfare maximization. Market – Policy and State – State vs. Market – Failure of Policy – Failure of Markets – Rationale for Government Intervention. Role of Quantitative Policy Analysis.

**Unit II** Demand- Supply Analysis: Demand analysis for policymaking – Alternative approaches to demand analysis – Policy implications. Supply response – Alternative approaches to measurement of supply response – Nerlovian models of supply response – Policy implications.

**Unit III** Household Behaviour and models: Household behaviour and policy analysis – Household models.

**Unit IV** Multi-Pronged approach to policy review: Partial equilibrium analysis – Concept of reference prices – Price distortions – indicators and impact. Transaction costs – Implications for efficiency and productivity – Institutional solutions – Multi market approach to policy analysis.

**Unit V** General equilibrium and programming: Social Accounting Matrices and multipliers – Computable General Equilibrium models to assess economy wide impact of policy changes. Fuzzy goal programming-Compromise programming.

**Practical :** Review of criteria for policy evaluation. Estimation of price elasticities. Review of estimation of complete demand systems. Estimation of Nerlovian supply Response model. Review of Household models. Specification and estimation of household models. Partial equilibrium analysis. Input–output table. Social Accounting Matrix – Construction of a SAM. Computation of Multipliers. Multi Market Analysis. Review of Computable General Equilibrium Models.

**AEC-608 Natural Resources Management** **2+1** **Sem. I**

**Unit I** Concepts Natural resources: definition - characteristics and classification. Stock dynamics of renewable and non-renewable resources. Equation of motion for renewable and non-renewable resources. Fundamental equation of renewable resources.

**Unit II** Models for economic view of natural resources: Growth curves of fishery and forest resources. The role of time preference in natural resource use. Simple two-period model of optimal use of renewable and non-renewable resources. Advanced models of optimal resource use – Static Vs. dynamic efficiency in natural resource use Applications of dynamic programming and optimal control.

**Unit III** Management of water resources: Economics of groundwater use - optimal extraction of groundwater. Analytical and numerical solutions for optimal inter-temporal allocation of natural resources. Optimal harvesting of single rotation and multiple rotation forests. Optimal management of fishery.

**Unit IV** Property Rights: Property rights in natural resources and their implication for conservation and management of natural resources. Management of common property natural resources – Institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource.

**Unit V** Dynamics of resource economics: Resource: scarcity – Natural resource degradation – Poverty and resource degradation – Natural resource accounting - Pricing and valuation of natural resources – Natural resources policy.

**Practical :** Derivation of the fundamental equation of renewable resources. Estimation of growth curves and stock dynamics for fishery and forestry resources. Simple two period problem of optimal resource use. Numerical solution for simple two-period model of dynamic efficiency in natural resource extraction. Multi-period dynamic efficiency. Using Excel Solver in solving dynamic natural resource harvesting problems. Using analytical solution procedures for solving natural resource management problems. Optimal control.

**AEC-609 Environmental Economics** **2+1** **Sem. I**

**Unit I** Overview of Environmental Economics: Environmental pollution as a consequence of market failure - Causes and consequences of market failure - Externalities - Public goods and externalities -Economics of pollution – Private vs. Social cost of environmental pollution – Property rights, environment and development – Theory of environmental policy.

**Unit II** Economic assessment: Environmental cost benefit analysis - Environmental impact assessment techniques Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.

**Unit III** Developmental aspects: Economic growth and environmental cost - Growth oriented economic policies and their environmental impacts - Population and environmental quality - poverty and environmental degradation – Sustainable development – Indicators of sustainable development – Issues in sustainable development.

**Unit IV** Accounting, Policies and Regulation: Environment, ecology and environmental accounting - Environmental pollution with respect to water and air - Land and forest resources related environmental pollution - Coastal externalities - Urbanization and environment - Basic approaches to environmental policy (Tax, subsidy, pollution permits etc.) Green taxes - Political economy of environmental regulation and management.

**Unit V** Environmental Issues: Transboundary environmental problems - Economics of global warming, climate change and emission trading - Environment, international trade and development.

**Practical :** Contemporary global environmental issues, movement, policies, programmes, laws and other regulatory mechanisms**.** Criteria for evaluating the environment related projects and review of Environmental Impact Assessment (EIA) techniques**.** Recreation demand models of environmental valuation. Contingent valuation techniques - Environmental Resource Accounting Techniques. Discussion on the techniques dealing with air pollution and review of case studies on air pollution and its impacts. Forest environment and wild life conservation. Green GDP and Green house insurance. Practical considerations and comparison of instruments of environmental policy. Non-point source pollution control methodologies. Environment in macroeconomic modelling. Meta-analysis, economic valuation and environmental economics. Multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems related to environment. Input output analysis, technology and the environment**.** Computable general equilibrium models for environmental economics and policy analysis.

**AEC-691 Seminar I** **1+0**

**AEC-692 Seminar II** **1+0**

**AEC-699 Ph.D Research** **0+75**

# B. SOCIOLOGY

## PROGRAMMES

**M.Sc.**

**Ph.D.**

## COURSE REQUIREMENTS

**M.Sc.**

| | |
|---|---|
| Fields of specialization | Rural Sociology, Social Change |
| Required courses | Soc.-501, Soc.-502, Soc.-503, Soc.-506/AEC-509 |
| Supporting courses | Stat.-502 and other supporting courses could be selected from the subject matter fields (other than minor) relating to area of special interest and research problem. |
| Minor fields | Agricultural Economics, Agricultural Extension Education, Extension Education and Communication Management, Agri-business Management, Business Management, Human Development and Family Studies, Statistics or any other as approved by the Dean, Postgraduate Studies. |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies |

**Ph.D.**

| | |
|---|---|
| Fields of specialization | Rural Sociology, Social Change |
| Required courses | Soc.-601, Soc.-602 |
| Supporting courses | The supporting courses could be selected from subject matter fields (other than Minor) relating to area of special interest and Research problem. |
| Minor Fields | Agricultural Economics, Agricultural Extension Education, Extension Education and Communication Management, Agri-business Management, Business Management, Human Development and Family Studies, Statistics or any other as approved by the Dean, Postgraduate Studies. |
| Deficiency Course | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**Soc. 101 Rural Sociology and Educational Psychology 2+0 Sem. I**

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology, Rural society, Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development. Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

**Soc. 102 Introduction to Rural Sociology 2+0 Sem. II**

Rural sociology- meaning, scope and significance. Structural differentiation in terms of difference and characteristics of rural and urban societies. Planned social change-approaches to rural planning, improvement and transformation and their shortcomings. Indian rural development programs (IRDPs). Indian rural social stratification. Caste- basic notions, changes and its role in economy and policy. Difference between caste and class. Backward classes and implementations of constitutional provisions. Indian rural social institutions- family and marriage (Nature, forms and changes). Economic-political- land relations and changes, rural poverty its manifestations and causes. Religious- functional significance of beliefs, traditions and customs. Rural social changes- processes and factors of transformation. Status of women in rural India and their role in rural and agricultural development.

**Soc. 103 Rural Sociology, Educational Psychology and Constitution of India 2+0 Sem. I**

Sociology and Rural Sociology: Definition, scope and its significance, Rural Society, Social Ecology, Social Groups, Social Stratification, Culture: Types and its elements, Social Institutions, Social Change and Development. Educational Psychology: Meaning & its importance. Behavior and its domains (Cognitive, Affective, Psychomotor), Motivation and theories of motivation, Personality, Learning, Intelligence. Constitution of India: Introduction, Preamble. Fundamental rights and duties. Directive Principles of State Policy. Constitutional provisions for welfare of SCs and STs, Minorities, Women and Children. Union Executive: President, Vice-President, Prime Minister, Council of Ministers- Powers and functions. Legislature: Powers and functions, Judiciary: Powers and functions, State Executive: Governor, Chief Minister, Council of Ministers, Electoral process. Human Rights Commission-Structure, powers and functions.

## Postgraduate Courses

**Soc.-501 Rural Society 3+0 Sem. I**

**Unit I** Origin, nature, scope and importance of rural sociology. Concepts and recent approaches used in the study of rural society and application of scientific method.

**Unit II** Agrarian social structure, rural settlements and salient features of rural society: Rural-urban differences, caste structure in rural set up, intercaste relations, Jajmani system, caste and politics. Rural economy. Rural family: their types and characteristics in different regions of India.

**Unit III** Role of religion in rural life. Peasant culture and dynamics of technology affecting agriculture. Landless agricultural labourers, their role and problems. Diffusion of innovations: elements of adoptions, stages in the adoption of innovation, adopter categories and their characteristics. Village cooperative societies. Peasant unrest and agrarian movements. Rural development programmes. Rural social problems: Farmer suicide, drug addiction, large scale youth emigration; magnitude, causes and consequences.

**Soc.-502 Society and Change 3+0 Sem. I**

**Unit I** Key concepts, social change, evolution, revolution, diffusion, development, progress, growth, cultural change, culture lag.

**Unit II** Cyclical and ancient theory of Oswald Spenglar, Pitrim Sorokin, A.J. Toynbee, Vilfredo Pareto.

**Unit III** Liner/evolutionary theories of Karl Marx, Thorstein Veblen.

**Unit IV** Factors of social change: demographic, economic, technological, legislative, physical, mass media.

**Unit V** Processes of Social Change: Sanskritization and de-Sanskritization, westernization, secularization, industrialization, urbanization, globalization, modernization. Depeasantization: extent, causes and consequences.

**Unit VI** Planned changed programme: objectives, achievements and impact. Problem of human adjustment in changing culture and society.

**Unit VII** Agricultural development and changes in various social institutions.

**Unit VIII** Social problems: communalism, factionalism, crime, juvenile delinquency, drug abuse, terrorism, etc.

**Soc.-503 Sociological Theories** **2+0** **Sem. I**

**Unit I** Auguste Comte and Herbert Spencer on society, humans and change, class, gender and race. Functionalism: Emile Durkheim

**Unit II** Functional Theories: Bronislaw Malinowski on functionalism and organicism. Talcott Parsons' systems of action, action schema, pattern variables, functional system problem and social change. Robert K Merton: middle range theory, functional analysis and deviance.

**Unit III** Conflict theories (Marx & Marxist) Thinkers; Karl Marx and the origins of conflict and critical theory. Analytical conflict theory of Ralf Dahrendorf. The conflict functionalism of Lewis A. Coser.

**Unit IV** George Herbert Mead's the self, self-interaction and symbolic meaning. Herbert Blumers interpretation and methodology.

**Unit V** Phenomenology and Ethno methodology, Harold Garfinkel. Peter Berger: the social construction of reality.

**Unit VI** Modernization- Jurgen Habermas

**Unit VII** Post Modernization - Michel Foucault and Jacques Derrida

**Soc.-504 Evolution of Social Thought** **2+0** **Sem. II**

**Unit I** Concept and characteristics of social thought. Evolution of social thought.

**Unit II** Classical Thinkers; Auguste Comte, law of three stages, concept of positivism, social control, social status and social dynamics. Emile Durkheim methodology, social fact, social solidarity, division of labour, suicide, and religion. German: Max Weber, social action, social understanding, religion, capitalism, social class and Bureaucracy. Ferdinand Tonnies: social entities and social norms.Karl Marx: dialectical materialism, class struggle, surplus value, social change,Herbert Spencer; evolution theory, state activity and natural rights.

**Unit III** Power Structuralist; Vilfredo Pareto; methodology, theory of residue, derivation, circulation of elites. American: Thorstein Veblen, theory of instinct, conspicuous surplus, social change

**Unit IV** Functional Theorist: Talcott Parsons: social action, pattern variable and social system. Pitrim A. Sorokin; geographical factors, socio-cultural dynamics, individual personality, power and morality. C.H. Cooley: groups and communication. A. Giddens: modernity and structuration

**Unit V** Mahatma Gandhi: State and society, religion and God, satyagraha, ahimsa and swaraj. D.P.Mukerji: Tradition and modernity. B.R.Ambedkar: Caste system and Indian bureaucracy.

**Soc.-505 Women Development Studies** **3+0** **Sem. I**

**Unit I** Key concepts: Agency and self. Women in household, market and state, Historical perspective on gender by different thinkers.

**Unit II** Past and present status of women, Employment of women in agriculture and non-agriculture sectors: their extent of participation and its impact on socio- economic status.

**Unit III** Nutritional status and health problems: reproductive, mortality and morbidity of women in different socio-economic categories. Public health facilities for women and their role.

**Unit IV** Gender and regional differences in literacy rate, dropouts and higher education: implications on family and in society.

**Unit V** Rape, Eve- teasing, trafficking, domestic violence, dowry, female foeticide, girl child labour, sexual harassment at work place: causes, consequences, remedies and data fact-sheet on crime against women.

**Unit VI** Honour killings: causes and remedial measures.

**Unit VII** State and central sponsored women welfare programmes

**Unit VII** Legislative measures and women empowerment: actions and achievements

**Soc.-506/AEC-509 Research Methodology for Social Sciences 1+1 Sem. I**

**Unit I** Concepts of research methodology: Importance and scope of research in agricultural economics. Types of research - Fundamental vs. Applied. Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.

**Unit II** Hypothesis-Framing and Testing: Hypothesis – meaning - characteristics - types of hypothesis – review of literature – setting of Course Objective and hypotheses - testing of hypothesis.

**Unit III** Sampling: Sampling theory and sampling design – sampling error - methods of sampling – probability and non-probability sampling methods - criteria to choose. Project proposals – contents and scope – different types of projects to meet different needs – trade-off between scope and cost of the study. Research design and techniques – Types of research design.

**Unit IV** Data Collection: Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing.

**Unit V** Data Analysis: Data coding, tabulation, cleaning. Multivariate analysis –factor analysis' PCA' cluster analysis. Universal procedures for preparation of bibliography – writing of research articles.

**Practical :** Exercises in problem identification. Project proposals – contents and scope. Formulation of Objective and hypotheses. Assessment of data needs – sources of data – methods of collection of data. Methods of sampling – criteria to choose – discussion on sampling under different situations. Scaling Techniques – measurement of scales. Preparation of interview schedule- Field testing. Method of conducting survey. Exercise on coding, editing, tabulation and validation of data, preparing for data entry into computer. Hypothesis testing – Parametric and Non-Parametric Tests. Exercises on format for Thesis / Report writing. Presentation of the results.

**Soc.-507 Social Stratification 3+0 Sem. I**

**Unit I** Key concepts, Hierarchy and difference in Caste and Class, Basic characteristics of Social Stratification, Historical and Contemporary thought and theory,

**Unit II** Generation of Social Stratification, Differentiation and ranking of status, Assessing the social importance of status, Differential rewarding of status,

**Unit III** Basic elements and processes, Property, Power and Prestige: Concept, measurement and problems.

**Unit IV** Functionalist perspective of Talcott Parsons, Middle Range Theories of Robert K. Merton, Conflict perspective of Social Stratification, Karl Marx and Modern Marxist Sociology, Analytical perspective of Ralf Dahrendorf and Lewis Coser

**Unit V** M.N. Srinivas's Varna and Caste,G.S.Ghurye's Features of caste system The ideology of Purity, Multiple references in Indian Caste System.

**Unit VI** The emergence of class, Marxian method of class analysis, Weber's class, status and party, Andre Beteille: Caste, Class and Power.

**Unit VII** Gender: Concept, measurement and implications in Indian context, Social mobility: Concept, measurement and analysis, Social Mobility and Conflict, Socio-economic inequality: Concept, measurement and analysis, Implications of social stratification for Indian society.

**Soc.-508 Rural Leadership** **2+0** **Sem. II**

**Unit I** Concepts of leader and leadership, authority, dominance, influence, social power. Social interaction and human groups, Types of Leaders, socio-cultural processes

**Unit II** Theories of social Interaction: Exchange theory (George. C. Homans), symbolic interactionism (George Herbert Mead), impression management (Erving Goffman), psycho-analysis (Sigmund Freud). Theories of Leadership: Trait, interaction, situational and functional.

**Unit III** Techniques of identifying rural leaders. Leader followers' relationship. Social values and leadership. Leadership and their role in community organization and changes. Panchayati raj system and peoples' empowerment. Emerging rural leadership patterns. Globalization and rural political structure.

**Soc.-509 Human Ecology and Dynamics of Population** **3+0** **Sem. II**

**Unit I** Concept of Ecology, Human Ecology, Population and Demography. Spatial distribution of population into village, city and region: concepts and facts.

**Unit II** Stages of social evolution from collection to town economy to post-industrial society.

**Unit III** Environmental pollution,land and water pollution in post-green revolution Punjab, carbon trading and climate change, Ecological degradation

**Unit IV** Malthusian and Neo- Malthusian Theory, Herbert Spencer's Biological Theory and Doubleday's Diet Theory

**Unit V** Demographic transition, population growth and distribution in India since 1901. Block 3-Determination of Population

**Unit VI** Fertility, Mortality, Morbidity and Migration: concepts, trends and determinants.

**Unit VII** Population and development, population as a resource for or constraint on development, population control: problems and perspective. Population policy socio-cultural factors affecting population growth, Research techniques of qualitative and quantitative aspects of demography.

**Soc.-510 Development and Quality of life** **2+0** **Sem. I**

**Unit I** Economic characteristics, welfare characteristics and sociological indicators of Development, Economic growth in Historical perspective

**Unit II** Growth and Development: A contrast in concepts, Developing nations: their common characteristics, Obstacles to growth and development

**Unit III** WW Rostow's stages of economic growth, John Meynard Keynes Theory, Karl Marx's theory of economic development, J. S. Schumpeter's theory of innovation.

**Unit IV** Ecological, economic and social indicators of development, Paths of Development with special reference to India

**Unit V** From Industrialism to Post Industrialism and Beyond, Post-modern social theory, Post-modernist: Michel Foucault, Post modernity: The Indian experience

**Unit VI** Concept variables and measurement, Human Development Index, Comparative scenario of developed and developing nations, Globalization, Scientific socialization, Impact of development on quality of life.

**Soc.-591 Seminar** **1+0**

**Soc.-599 Master's Research** **0+30**

## Ph.D. courses

**Soc.-601 Sociology of Development** **3+0** **Sem. II**

**Unit I** Sociology of Development, scope of sociology of development, sociological and psychological aspects of economic growth. Significance of culture in the process of development, Indicators of development.

**Unit II** Human Development perspective, sustainable Development perspective, Environmental degradation and politics of environmental pollution.

**Unit III** Stages of Economic growth theory, Theory of Economic growth, Theory of Positivistic Development, Theory of Realistic Development.

**Unit IV** Paul Baran's on underdeveloped; The World system theory; Frank's theory and Amin's theory of underdevelopment.

**Unit V** Development of economic, political, educational and religious institutions of simple and advanced societies.

**Unit VI** Social stratification: its visibility postulates, socio economic and environmental implications of development efforts, globalization and its impact on traditional social setup.

**Unit VII** Emergence of new institutions and their interaction pattern.

**Soc.-602 Recent Advances in Rural Sociology** **3+0** **Sem. II**

**Unit I** Critical evaluation of the recent works of rural sociology. Contribution of sociology, anthropology, economics and psychology to the understanding of structure and functions of rural society.

**Unit II** Developmental aspects in Rural Sociology; Change in development perspective, planning and social action and rural social policy, social values and developmental change, socio- spatial and economic limits of social change, socio-psychological variables in planned development. Formation and destruction of communities and rural development planning.

**Unit III** Policy Planning and various programmes for rural people;

Policy planning and administration concerning development of rural areas, family, child, women and marginalized sections. Evaluation of various programmes of rural development.

**Unit IV** Agricultural development and the farmers of the world: experience of developed and developing nations. Emerging social trends and their consequences in rural India. Land tenure and agrarian relations. Social structure and agrarian relations. Peasant unrest-causes and consequences. Role of migrant labour in agriculture. Rural indebtedness, farmer's suicides.

**Soc.-603 Contemporary Rural Social Problems** **3+0** **Sem. I**

**Unit I** Concept of organization, disorganization, social problem, types and dimensions of social problems

**Unit II** Level of social organization, level of social problems, methods of studying rural problems: Survey, Experiments, Observation, (field research), Secondary data

**Unit III** Unemployment: magnitude, present features, measures taken. Population explosion: causes, effect and population policy, Problems of abundance and poverty (Family, household)

**Unit IV** Scheduled castes, scheduled tribes (Identity crisis and assertion), other backward castes, Communalism and secularism

**Unit V** Youth unrest and agitations, Drug abuse and drug addiction.

**Unit VI** Child abuse and child labour. Violence against women. Illiteracy, crimes and criminals. Intellectual, ethical and social implications of social problems. The changing rural society.

**Soc.-604 Demographic Analysis** **3+0 Sem. I**

**Unit I** Inter-relations of population dynamics and social change. Problems of data collection and measurement in planning for social development, Theories of demography

**Unit II** Sources of demographic data: Census method, sampling method and registration method. Techniques of population analysis

**Unit III** Definitions and allied terms of population; Fertility, reproduction, mortality, fecundity, migration, age and sex-specific distribution of population, density of population, dependency ratio, sex ratio, age at marriage and life expectancy.

**Unit IV** Village and urban community: Growth and features of village and city communities. Urban rural contrast, The Nation: growth and features

**Unit V** Determinants of Population and projections- Social determinants of fertility, mortality and rate of change. Causes of population change and consequences. Population projections.

**Soc.-605 Studies of Marginalized Sections** **2+0 Sem. II**

**Unit I** Marginalized sections, subaltern sections, definition and distribution of Scheduled caste, scheduled tribes and other backward classes, Forms of deprivation, past and present status

**Unit II** Theoretical perspectives of subaltern David Hardiman, B.R. Ambedkar, Ranajit Guha, Gayatri Chakravorty Spivak

**Unit III** Prohibitions and atrocities against scheduled castes, backward castes and women. Phenomenon of untouchability. Dalit's unrest and crisis of identity in India.

**Unit IV** Women: gender inequality and disabilities: past and present changing status of women.

**Unit V** Reservation policy. New trends in reservation and its implication in society.

**Unit VI** Role of social reform movement, institutions, and individuals in welfare and development of deprived sections.

**Soc.-606 Environment and Social Organization** **2+0 Sem. II**

**Unit I** Meaning and significance of environment and social organisation, Relationship between environment and Social Organisation, Causes and consequences of environment degradation.

**Unit II** Air, noise, water, land and agriculture pollution: causes and consequences. Issues of climate change and, Carbon trading: causes and consequences.

**Unit III** Agricultural environment in traditional and modern societies. Conditioning effects of environment on social organization.

**Unit IV** Meaning of sustainable development and environmental movements and their role.

**Unit V** Environmental ethics. Legislative measures to check environmental degradation

**Soc.-607 Peasants Movements and Indian Agrarian Structure** **2+0 Sem. II**

**Unit I** Conceptual and historical perspectives of peasantry in India. Importance of peasantry in Indian society.

**Unit II** Agrarian structures of traditional and contemporary societies and land tenure systems. Types of peasants. Peasant culture.

**Unit III** Santhal Insurrection (1855), Peasant revolt in Punjab (1930), Champaran movement 1917, Kheda peasant struggle 1918, Bardolisatyagraha 1928, Moplah rebellion 1921.

**Unit IV** Peasants movement after independence: The Telangana Rebellion (1947-51), Naxalbari Peasant Struggle (1967)

**Unit V** Land reforms: targets and achievements. Social impact of land reforms.

**Unit VI** Contemporary agrarian problems. Globalization and its impact on peasantry in India.

**Soc.-608 Society in India** **2+0** **Sem. II**

**Unit I** Unity in diversity, racial and cultural composition in Indian society.

**Unit II** Ashrama and Varna system. Sacraments and their roles.

**Unit III** Concept of caste and class: meaning, features and functions. Difference between caste and class. Kinship tradition and change. Untouchability

**Unit IV** Tribal Society: geographical distribution of tribes, clan, totemism, taboo, witchcraft, magic, religion, tribal development and change.

**Unit V** Rural society, village community, tradition and change.

**Unit VI** Changing land use patterns and its consequences. Occupational mobility and its implications.

**Unit VII** Concept of Urban society, urban centre, traditional and modern, urban ecology, urbanization and urbanism, urban planning and development.

**Unit VIII** Increasing global interaction and changes in the context of Indian society.

**Soc.-691 Seminar I** **1+0**

**Soc.-692 Seminar II** **1+0**

**Soc.-699 Ph.D Research** **0+75**

# AGRICULTURAL JOURNALISM, LANGUAGES AND CULTURE
# JOURNALISM

## PROGRAMMES

### MJMC (Masters in Journalism and Mass Communication)

## COURSE REQUIREMENTS

### MJMC

| | |
|---|---|
| Field of Specialization | Journalism & Mass Communication |
| Core Courses | Jour.-501, Jour.-502, Jour.-503, Jour.-504, Jour.-505, Jour.-506 and at least one course from Jour.-507 to Jour.-509 |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problem. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Extension Education, Sociology or any other as approved by the Dean Postgraduate Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Journalism

## Undergraduate Courses

**Jour. 302 Agricultural Journalism** **2+1** **Sem. II**

Nature and scope of agricultural journalism. Characteristics and training of the agricultural Journalist, comparison of agricultural journalism with other types of journalism, newspapers and magazines as communication media. Characteristics, kinds, functions, form, content, style, language and parts of newspapers and magazines. Types, subject matter and structure of agricultural journalism. Gathering agricultural information, sources, interviews, coverage of events, abstracting from research and scientific materials, wire services and other agricultural news sources. Organizing the material, treatment, writing the lead and the body and readability measures. Illustrating agricultural stories, use of photographs, artwork and writing the captions. Editorial mechanics, copy reading, headline and title writing, proofreading and lay outing.

**Practicals :** Practice in interviewing, covering agricultural events, abstracting stories from research and scientific materials and from wire services, writing different types of agricultural stories, electing pictures and artwork for the agricultural story. Practice in editing, copy reading, headline and title writing, proofreading and lay outing. Testing copy with a readability formula. Visit to a publishing office.

## Postgraduate Courses

**Jour.-501 Print Journalism** **1+2** **Sem. I**

**Unit I** Introduction to journalism, history of Indian press and printing, printing processes attributes of a reporter, news syndicates and agencies, concept, sources and elements of the news, press releases, flash messages.

**Unit II** Kinds of feature, feature article and editorial writing, types and sources of editorials, principles of editing, headline writing, illustrations, principles of design and layout.

**Unit III** A brief introduction to recent trends in mass media, cultural imperialism, media activism, agenda-setting, gatekeeping, page 3 journalism.

**Practical :** Writing letters to the editor, newsgathering, writing news and headlines, conducting interviews, writing specialty stories, planning and writing features and articles, news interpretation, editorial writing, proofreading and copy-editing, use of appropriate computer applications for Desk Top Publishing, dummy making, page making, production of lab journal.

**Jour.-502 Online Journalism** **2+1** **Sem. II**

**Unit I** Introduction to Online Journalism. Basic terminology, a technical history of the Web and early online media.

**Unit II** Comparative Media Characteristics (print and online), online writing and story structure, issues in online research and information gathering, the concept of interactivity and its tools, ethical dilemmas in online journalism.

**Unit III** Blogging and participatory journalism, issues concerning blogging, online advertising, virtual community formation v/s atomization, massification v/s individuation of news.

**Unit IV** Web edition and e-edition, understanding the difference between web edition and e-edition of newspapers, meta journalism, extensions of new media e.g. RSS feeds, podcasting and wireless paper, convergence.

**Practical :** Uses of the Internet, using search engines such as Google effectively, finding useful information from local, national, and international sources, content writing, news-site designing, making a webpage using HTML.

**Jour.-503 Media Planning and Advertising** **2+1 Sem. I**

**Unit I** Introduction to advertising, origin and growth, terminology, advertising, its classification, objectives, strategies at different levels and its future.

**Unit II** Advertising industry, marketing mix, promotional mix and the communication process, structure of advertising industry – advertising agencies, advertising coverage, types of advertising media.

**Unit III** Advertising codes, regulations and ethics, consumer redressal forums, advertising and social issues, controversial advertising, issues concerning surrogate advertising.

**Unit IV** Constructing an advertisement, types of consumers and buying motives, media selection and scheduling, difference between advertising and PR, media planning and buying, brand positioning.

**Practical :** Preparing media-specific advertisement copies, ad layout and design, computer graphics using appropriate applications.

**Jour.-504 Agricultural and Development Journalism** **1+1 Sem. II**

**Unit I** Developmental Media and its meaning, scope and importance of development journalism, problems of rural development, development agencies, development media theory and democratic participant theory, dominant paradigm v/s participatory approach.

**Unit II** Human development index, making sense of development statistics, determinants of development, nation building and uplifting quality of life.

**Unit III** Agriculture and rural development schemes, agricultural news story structure, agricultural media dynamics and ethics, editing scientific papers, policy reports, public understanding and media coverage of environmental issues.

**Unit IV** Developmental journalism and media, use of traditional media, rural press, contribution of vernacular press, role of IT in agricultural and rural development, right to communicate and New World Communication Order, WTO.

**Practical :** Planning and writing development articles, news and information material on farm, home and community activities, editing of popular leaflets and bulletins based on technical material, media mix campaigns for specific targets.

**Jour.-505 Media Ethics and Press Laws** **3+0 Sem. II**

**Unit I** Ethical reporting, code of ethics, social responsibility, invasion of privacy, sting operations and ethical issues, organizational pressures in media ethics.

**Unit II** Six fundamental rights, right to equality, freedom, especially freedom of speech and expression, against exploitation, religion, cultural and educational rights, constitutional remedies, freedom and accountability of press.

**Unit III** Press Laws in India, official Secrets Act 1923 – extent, application, definitions and penalties, laws of sedition, defamation, criminal and civil law, exceptions and liabilities, libel and slander, contempt of Court Act 1971, defenses and punishment, contempt of Legislature, privileges of the parliament and press, Press Council Act 1978, composition, term, objects and functions, power to censure. Press Commission, Copyright Act 1957 – meaning, term and infringements, registration of journals, Press and registration of Books Act 1867, Information Technology Act 2000 and cyber rights, Right to Information Act 2005, media's role in promotion of human rights, editor's freedom, case studies.

**Jour.-506 Communication Theories and Research Techniques** **2+1 Sem. I**

**Unit I** Basics of communication, definition, scope and importance of communication, kinds of communication, intra-personal, inter-personal, group and mass communication, verbal and non-verbal communication.

**Unit II** Communication process, barriers to communication, diffusion process, one-step, two-step and multi-step flow.

**Unit III** Communication theories, communication models, theories: cognitive dissonance, selective exposure, perception and retention, uses and gratification approach, cultivation approach.

**Unit IV** Introduction to research methods for Mass Media, research methods and practices for mass media, types of research e.g. survey research, readership studies, content analysis, etc., selection and formulation of research problems, method and style of writing research report.

**Practical :** Selecting a problem, conducting field surveys, writing reports, research proposal writing etc. Conducting pilot studies and presenting reports

**Jour.-507 Corporate Communication and Public Relations 2+1 Sem. I**

**Unit I** Basics of corporate communication, corporate communication, concept, definition, nature and scope, effective means of organizational and social communication.

**Unit II** Corporate communication and publicity, differences between corporate communication and publicity, propaganda, advertising and lobbying, corporate citizenship and culture, function of consultancies/ image advisories, event, crisis, image and conference management, counselling, issue support, direct marketing, budgeting.

**Unit III** Media and business communication, publics for corporate communication, media management – principles, ownership and organizational structure in management and editorial department, circulation department.

**Unit IV** PR management, definition and scope of public relations, tools and techniques of PR, use of print media, audio-visual aids and electronic media in PR, role of public relations in various institutions, public opinion, propaganda and PR, ethics in PR.

**Practical :** Organizing exhibitions and campaigns, organizing conferences, image management of university/ college/ department, media counselling and ghost writing for organizational heads, conducting visits, motivational campaigns for organizational staff, business correspondence, liaison with administration, space marketing features, making posters, handbills for PR campaigns.

**Jour.-508 Photo Journalism 1+2 Sem. I**

**Unit I** History and development of photo journalism, photo journalism – brief history and technological developments.

**Unit II** Photography and mass media, role of photography in communication, importance and impact of pictures in publications, understanding a photograph, qualities of a good photograph, reproduction qualities of a photograph. Selection and editing of photographs, writing captions, ethics of photo journalism.

**Unit III** Photo Legalities, legal limitations of a photo journalist, ethics and aesthetics of image manipulation.

**Practical :** Camera basics and terminology, components and controls in a camera, types of camera, choosing a camera, importance of lighting and natural /artificial lighting, handling a camera, camera techniques, shutter, aperture and lens controls, elements and composition, developing and printing of photographs, digital photography, file formats and storage, image editing/manipulation in Photoshop. Printing and printers, photo sharing via internet, photo galleries, preparing photo features.

**Jour.-509 Broadcast Journalism 1+2 Sem. I**

**Unit I** Basics of broadcast Journalism, principles and characteristics of broadcast journalism, it's comparison with print journalism.

**Unit II** Basic Terminology in radio and TV journalism, history of radio and TV, early experiments and inventions, ethics in broadcasting, organization and functioning of radio and TV stations.

**Unit III** Writing for Media, writing for rural radio and TV programmes, differences between ham, community and FM radio, evolution of Internet Protocol TV (IPTV), steps in production including pre and post production stages, creating effective newscasts, narrowcasting v/s broadcasting.

**Unit IV** Role of electronic media in rural development, impact of broadcasts and telecasts on rural life, problems of broadcasting/ telecasting.

**Practical :** Handling video camera, conceptualizing, drafting, interpreting and writing a radio script, drafting, interpreting and writing a TV script, preparing interview schedule for a radio/TV programme, scripting a radio/TV talk, reporting of university activities, accomplishments and research highlights through electronic media, editing scripts for development programmes on radio and TV, preparing a short documentary film.

**Jour.-591 Seminar** **1+0** **Sem. I, II**

**Jour.-595 Training in Journalism** **0+15 (NC)** **Sem. II**

For practical training, students will be attached to a newspaper/news agency/radio/TV for eight weeks.

**Jour.-599 Project Research** **0+15 (NC)** **Sem. I, II**

## ENGLISH

### Undergraduate Courses

**Eng. 91 General Reading, Vocabulary Building and Translation** **2+1** **Sem. I**

An anthology of modern prose and poetry for intensive study, a book of biographies for general reading.

**Practical :** Sequence of tenses, antonyms, synonyms, one-word substitution, formation of words, words used as different parts of speech, transformation of sentences, simple, compound and complex, interchange of voice, narration and degrees of comparison, letter writing for personal communication. Translation from English into vernacular. A special question for foreign students in lieu of translation.

**Eng. 92 Reading, Comprehension, Paragraph Writing and Applied Grammar** **2+1** **Sem. II**

An anthology of modern prose for intensive study, a book of biographies for general reading.

**Practical :** Use of articles, pronouns, conjunctions and prepositions, position and order of adverbs, tenses, paragraph writing, comprehension of unseen passages, punctuation, words often misspelt. Translation from vernacular into English. A special question in lieu of translation for foreign students.

**Eng. 93 Conversational Structure and Communicative Function** **2+1** **Sem. I**

Structure of English Language,Lexical level: structural words, content words, meaning of words, connotations and denotations, relation of words in sentences, phrasal/clausal level, phrase, form and structure, clause, form and structure, forms of sentences, sentences based on structure, function and purpose, Peculiarities of English Language, the use of articles, emphatic and personal pronouns, reduction of articles, auxiliary verbs, conjunctions, prepositions and pronouns in connected speech. Situational and functional use of English Language, factors, role of audience, managing the pace of information and delivery, time and stress management, use of factors and functions in real-life situations.

**Practical :** Functional use of language, greeting and introduction, request, permission, instruction and direction, offering help etc. Situational use of language, at the bank/post office/ college office, at the grocer, at the temple, at the college canteen or restaurant, at the police station, at the railway station/ bus station, at the medical shop, at the library, at the travel agency, booking a room in a hotel, facing interviews. etc.

**Eng. 94 Discourse Patterns in Spoken English** **1+2** **Sem. II**

Patterns in spoken English, back channel, deixis, clause combining, conversational historical present, discourse markers discourse markers, general extenders, hedges intensifiers, narrative structure, nonstandard grammar, non-fluency textures, repetition, false starts, quotative expressions, rhetorical strategies, slang. Discourse analysis, voice modulation, use of pitch and tone depending on the structure of sentence, importune of pause and stop in spoken English, body posture and communication.

**Practical :** Using language the effective communication, PowerPoint presentations, preparation and delivery of power point presentation, role of add-ons (illustrations, pictures and animations) in power point presentations, conversation with pattern and content, dialogue base study of structural patterns, activity using non-verbal skills to narrate a story/mime, voice modulation exercises, extempore and speech delivery, interview skills, soft skills, discussion skills, speaking activities, integrated task and independent task practice, role play, debates, group discussions.

**Eng. 101 General English** **1+1** **Sem. I & II**

Reading Comprehension, Vocabulary Building, Antonyms, Synonyms, words often confused due to similar spellings or pronunciations. Functional grammar, Error Analysis, Articles, prepositions, verbs, pronouns, adjectives and adverbs. Basic sentence patterns in English, Agreement between subject and verb, proper use of phrases and clauses. Development of paragraphs, Cohesion, coherence and style. Technical Writing Skills, Nature of technical style vs. general style, writing process (prewriting, rewriting and editing). Paragraph writing, précis writing, summarizing, abstracting. Preparation of Curriculum Vitae and Job applications. Note-taking, field diary and lab record, indexing, footnote and bibliographic procedures.

**Practical :** Reading skills, Reading and comprehension of general and technical articles, vocabulary building tasks, exercises to help the students in the enrichment of vocabulary based on competitive examinations. Writing Skills, Note-taking, field diary and lab record, précis writing, summarizing, abstracting, preparation of curriculum vitae and job applications. Reference Skills: Use of dictionary and thesaurus, indexing, contents, glossary, footnote and bibliographic procedures.

**Eng. 201 Communication Skills and Personality Development 1+1 Sem. I & II**

Communication Skills, Meaning and process of communication, verbal and nonverbal communication, oral presentation skills, individual and group presentations, extempore presentations, public speaking, group discussions and interviews. Soft Skills, introduction to soft skills and hard skills. Personality, meaning and definition of personality, theoretical perspectives on personality, behavioural trait and humanistic personality patterns, molding the personality patterns. Personality development, self-perception, self-concept, self-esteem and gender stereotyping, persistence and changes in personality determinants (physical, intellectual, emotional, social, educational and family), aspirations, achievements and fulfillment. Cosmopolitan culture, presentational etiquettes, formal dressing, formal greetings. Stress and conflict management, goal setting, decision making, career planning, resume building, interview skills.

**Practical :** Organizing seminars and conferences, developing questionnaire to study impact of physique, educational institutions, aspirations on personality, developing questionnaire to study social prescriptions, gender and family on personality, aspirations and achievements. Oral presentation skills, video recorded mock group discussions and interviews, exercises on attitude management, setting and achieving a short term goal, creating a personal vision statement of life, practicing conscious body postures and movements, rapport building, video recorded practical to evaluate change in confidence level, team work exercises, time management.

## Postgraduate Courses

**Eng.-501 Advanced Comprehension and Composition 2+1 Sem. I**

**Unit I** Comprehension of passages selected from journals, newspapers and books, style, structure and format of comprehension, prerequisites of writing a comprehension, epitomization, summaries, précis, book review, abstract and synopsis writing, diction.

**Unit II** Basics of word etymology, definitions, word meaning, denotation and connotation, definitions and meanings, concrete and abstract words, definitions and meanings

**Unit III** Etymology and sentence structure, choice and arrangement of words, rules of proximity, avoiding a split infinitive, use of connectives, avoiding ambiguity, position of adverbs, clichés, idioms and phrases, figurative language, words causing confusion, metaphor, simile, homonyms, homophones, pair of words.

**Unit IV** Principles of effective writing, basic units of writing, kinds of sentences, classification by function and structure, important grammatical problems, objectivity, conciseness, concreteness, directness, forms of writing, scientific and technical writing, reports, articles, papers, manuals, dissertations and theses, correspondence, styles of writing, cultural, creative, journalistic writings.

**Practical :** Exercises in Comprehension and epitomization, summaries, précis, abstract and synopsis writing, writing of reports and book reviews, usage and composition, writing a creative piece on a given subject, writing of words causing confusion, metaphor, simile, homonyms and homophones, styles of writing, cultural, creative, journalistic writings, listening to at least two tapes regarding British pronunciation techniques, recorded conversation aimed at testing the listening comprehension of students, group discussions on the current issues concerning society, planning for meetings, holding mock meetings, facing interviews by holding mock interviews, presentations by using PowerPoint and LCD projector, Public speaking on any topic.

**Eng.-502 Contemporary Prose 2+1 Sem. II**

**Unit I** Contemporary prose, critical study of selections from contemporary prose representing creative prose, style, structure and format of prose.

**Unit II** Prerequisites of writing a prose, use of figurative language, diction, choice of words and arrangement of words.

**Unit II** Study of Selected Prose: Charles Lamb: Dream Children, Bachelor's Complaint, Francis Bacon: Essays, cultural writings, style, structure and format of cultural prose, prerequisites of writing a cultural prose

**Unit III** Contemporary prose and colonial theories, glimpses of colonialism, post colonialism and Diaspora in cultural prose.

**Unit IV** Various forms of scientific writings, theses, technical papers, review, manuals etc., various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion) diction, choice of words and arrangement of words.

**Unit V** Journalistic writing with emphasis on Indo-Anglian Prose, various forms of journalistic writings, Introduction, story board, style, structure and format of journalistic prose, prerequisites of writing a journalistic prose, important works of prose, especially journalistic, by western and Indian writers known for thought and style.

**Practical :** Writing reviews and popular articles, listening to at least two tapes regarding British pronunciation techniques, recorded conversation aimed at testing the listening comprehension of students, group discussions on the current issues concerning society, planning for meetings, holding mock meetings, facing interviews by holding mock interviews, presentations by using PowerPoint and LCD projector, public speaking on any topic.

**PGS-502 Technical Writing and Communications Skills. 0+1 Sem. I& II**

**Practical :** Various forms of scientific writings, theses, technical papers, reviews, manuals, etc., various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion), writing of abstracts, summaries, précis, citations etc., commonly used abbreviations in the theses and research communications, illustrations, photographs and drawings with suitable captions, pagination, numbering of tables and illustrations, Writing of numbers and dates in scientific write-ups, editing and proof-reading, writing of a review article, Communication Skills: Grammar (Tenses, parts of speech, clauses, punctuation marks), Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription, Accentual pattern: Weak forms in connected speech, participation in group discussions, facing an interview, presentation of scientific papers.

**PGS-506 English with Critical Analysis and Verbal Reasoning Skills 0+1 Sem. I & II**

**Practical :** Vocabulary Building: Greek and Latin Roots, prefixes and suffixes, identifying pairs, synonyms and antonyms, idioms and common phrases. Verbal Reasoning: Introduction and types, analytical reasoning and logical reasoning, propositions, premises and conclusions, arguments and reason, logical sequence of words, syllogism, cause and effect, venn diagram, analogy, coding and decoding cloze test. Sentence Analysis: Sentence structure, sentence equivalence, pivot, target, clue, single blank sentences, double-blank sentences, answer choice analysis, text completion. Proof-reading: Error spotting, correcting grammatical structure, common grammatical mistakes.

## PUNJABI

### Undergraduate Courses

**Pbi. 101 Basic Punjabi** **0+2 (NC)** **Sem. I**

(For undergraduate students who have not studied Punjabi upto Matric or 10 +2 level)

**Practical :** Gurmukhi script, sequence of letters in Punjabi alphabet and their pronunciation, similarities and dissimilarities of gurmukhi and devnagri script, why the script of Punjabi is called gurmukhi, linguistics, definition and its application on gurmukhi script, a brief note on various dialects of Punjabi e.g. Malwai, Majhi, Doabi, Puadhi,Dogri, Kangrietc.and dialects of west Punjab, Matras, nasal sounds and their signs, word formation and pronunciation, standard spelling, correct incorrect, sentence structure, basic Punjabi grammar, idioms, proverbs, synonyms, antonyms, gender, number, one word substitution, pair of words, words having multiple meanings, agricultural terminology, paragraph, precise and letter writing, translation of simple passages from English to Punjabi, practice in spoken Punjabi, comprehension of a passage related to agriculture, practice in creative writing.

**Pbi. Cul. 101 Punjabi Culture** **2+0 (NC)** **Sem. I**

**(For ICAR nominees and Foreign Students)**

Culture, definition, concepts and scope, Punjabi Culture, characteristics of Punjabi culture, Punjabi culture in the context of geography, history, language, literature, religion, art, folklore, fairs and festivals of Punjab as mirror of Punjabi culture, sports and games, customs, beliefs, rituals, legends and different occupations of rural Punjab, changing patterns of Punjabi culture through the ages, socio economic and political changes in Punjab in the context of changing international scenario, technical developments in the field of agriculture leading to the Green Revolution in the Punjab and its impact on the culture of the State, impact of Post- Green Revolution developments on the culture of Punjab like social tensions as result of Green Revolution, changed life styles and its impact on Punjabi culture.

### Postgraduate Courses

**Pbi.-501 Punjabi Literature and Culture** **3+0** **Sem. I**

**Unit I** Major movements in Punjabi Culture with special emphasis on gurmat, sufi, kissa and heroic poetry, revivalist and reformist trends, western influence on Punjabi Culture and Literature impact of national liberation movement, progressive movement and experimental trends in Punjabi literature.

**Unit II** Culture, concepts, scope, Punjabi culture: characteristics of Punjabi culture, Punjabi culture in the context of geography, history, language, literature, religion, art and architecture, folklore, drama and theatre, handicrafts, fairs and festivals, sports and games, customs, beliefs, values, rituals, myths and legends and religion, changing patterns of Punjabi culture through the ages, socio-economic and political changes and technological developments since partition and their impact on contemporary Punjabi culture, Punjabi ethos.

**Pbi.-502 Punjabi Journalism** **2+1** **Sem. II**

**Unit I** Origin and Development of Punjabi journalism. Origin and development of Punjabi journalism, contribution of Christian missionaries, role of Singh Sabha, Chief Khalsa Diwan, Akali and religious movements, secular trends.

**Unit II** Contemporary trends, prominent Punjabi dailies, weeklies and monthlies, famous Punjabi journals.

**Practical :** Writing articles, features and news on socio-historical and political movement, eminent personalities and writers, editing Punjabi News, translation news in Punjabi, common grammatical problems, writing headlines and photo captions in Punjabi analysis of editorials.

## FOREIGN LANGUAGES

**French-501 Proficiency Course in French** **2+0 Sem. I & II**

**Unit I** French alphabet and sound system (sounds of individual letters, diphthongs, rules of pronunciation etc).

**Unit II** Articles (definite, indefinite, partitive, contracted) and present tense/present perfect tense of verbs of the three groups such as parler, finir, entendre etc., conjunctions (maiscommesi, meme si, cependant etc.), gender and number of nouns, conjugations (Affirmative, negative, interrogative), prepositions (sur, sous, devant, derriere, dans, a etc.) adverbs, adjectives (common adjectives which are placed before or after nouns, possessive adjectives etc.) and pronouns (simple pronouns, personnel pronouns).

**Unit III** Cardinal numbers from 1 to 100, translation from French to English (of words, sentences and passages), accent (aigu, grave, circonflexe).

## E. LIBRARY AND INFORMATION SCIENCE

### Postgraduate Courses

**PGS-501 Library and information Services** **0+1 Sem. I & II**

Introduction to library and its services; Role of libraries in education, research and technology transfer; Library classification and cataloguing systems; Organization of library documents; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing of information from reference sources; Literature survey; Citations techniques/ Preparation of bibliography; Use of CD-ROM Database; Online Public Access Catalogue and other computerized library services; Use of internet including search engines and its resources ; e-resources access methods (CeRA, Krishkosh, etc.)

**RPE- 601 Research and Publication Ethics** **1+1 Sem. I & II**

**(Compulsory supporting course for Agronomy and Agricultural Economics)**

Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgments and reactions; Publication ethics: definition, introduction and importance; Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.; Conflicts of interest; Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types; Violation of publication ethics, authorship and contributor ship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals; Scientific conduct: Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP); Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data.

**Practical :** Open access publications and initiatives; SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies; Software tool to identify predatory publications developed by SPPU; Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.; Publication Misconduct: Group discussions on subject specific ethical issues, FFP, authorship; Conflicts of interest; Complaints and appeals: examples and fraud from India and abroad; Use of Software tools like Turnitin, Ouriginal (formerly Urkund) and other open source software tools; Databases: Indexing databases; Citation databases: Web of Science, Scopus, etc; Research metrics: Impact Factor of journal as per Journal Citation Report, SNIP,SJR, IPP, Cite Score; Metrics: h-index, g index, i10 index, altmetrics.

# MATHEMATICS, STATISTICS AND PHYSICS

## PROGRAMMES

**M.Sc.**
**Five Year Integrated M.Sc. (Hons.)**

## COURSE REQUIREMENTS

**M.Sc. (Mathematics)**

| | |
|---|---|
| Fields of specialization | Elastic Vibration, Linear Algebra, Numerical Analysis |
| Required courses | Math.-521, Math.-523, Math.-525, Math.-526, Math.-527, Math.-528, Math.-529, Math.-530, Math.-535 |
| Supporting courses | Stat.-502, Stat.-522, Stat.-501, CSE-501, CSE-504, AEC-505 |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Statistics or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by the student's Advisory Committee and by the Dean, Postgraduates Studies |

**M.Sc. (Statistics)**

| | |
|---|---|
| Fields of specialization | Design of Experiments, Sample Surveys, Applied Statistics |
| Required courses | Stat.-552, Stat.-553, Stat.-562, Stat.-563, Stat.-564, Stat.-571, Stat.-572, Stat.-573 |
| Supporting courses | CSE-501, AEC-505, AEC-508, AEC-509 |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Mathematics or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by the student's Advisory Committee and by the Dean, Postgraduates Studies |

**M.Sc. (Physics)**

| | |
|---|---|
| Fields of specialization Physics | Solid State Physics, Nuclear and Particle Physics, Theoretical Physics, Agricultural Physics |
| Required courses | Phys.- 501, Phys.- 502, Phys.- 503 , Phys.- 504, Phys.- 505, Phys.- 506 |
| Supporting courses | Stat.-502, AGM-501, EMN-521, CSE-501 |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Mathematics, Chemistry or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by the student's Advisory Committee and by the Dean, Postgraduates Studies |

**5-Year Int. M.Sc. (Hons.) Physics**

| | |
|---|---|
| Fields of specialization | Solid State Physics, Nuclear and Particle Physics, Theoretical Physics, Agricultural Physics |
| Required courses | All courses listed for semesters I to VI and Phys.- 501, Phys.- 502, Phys.- 503 , Phys.- 504, Phys.- 505, Phys.- 506 |
| Supporting courses | Stat.-502, AGM-501, EMN-521, CSE-501 |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Mathematics or any other as approved by the Dean Postgraduate Studies. |
| Deficiency courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

# DESCRIPTION OF COURSE CONTENTS

## A) MATHEMATICS

### Undergraduate Courses

**Math. 101 Basic Mathematics-I** **3+0** **Sem. I**

Complex numbers: Properties of real numbers, complex numbers, their addition, multiplication and division, square root of complex numbers, cube roots of unity and their properties, De-Moivre's theorem; Theory of equations: Solution of quadratic equation, equation reducible to quadratic equation, relation between roots and coefficients, nature of roots and formation of quadratic equation with given roots.

Geometric series: nth term of G.P. series, sum of G.P. series, geometric mean; Harmonic series, harmonic mean; Arithmetico geometric series and special series $\sum n$, $\sum n^2$, $\sum n^3$. Partial fractions; Logarithms; Binomial theorem for any index: Expansion, middle term, general term, terms independent of x.

Trigonometry: Trigonometric ratios, allied angles, graphs of trigonometric functions; Addition and subtraction formulae; Product and sum formulae; Multiple and sub-multiple angles, sine, cosine and projection formulae; Area of a triangle.

**Math. 102 Basic Mathematics –II** **3+0** **Sem. II**

Matrices and Determinants- definition of matrix, addition, subtraction, multiplication and inverse of matrix. Solution of linear equations- by Crammer's rule and inverse of matrix. Functions. Limit- introduction, left handed and right handed limits, calculation of limits using standard formulae. Continuity- definition, continuity of algebraic, trigonometric and exponential functions. Differentiation- differentiation by first principle, sum, difference, product, quotient formulae, using chain rule, and of functions in parametric and implicit form, logarithmic differentiation. Geometrical interpretation of derivative. Successive differentiation. Maxima and minima. Tangent and normal. Integration- integration by substitution, trigonometric substitution, partial fractions and by parts.

**Math. 103 Elementary Mathematics** **2+0** **Sem. I**

Straight lines : Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope-point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form of equation of line, General form of equation of line, Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral. Circle: Equation of circle whose centre and radius is known, General equation of a circle, Equation of circle passing through three given points, Equation of circle whose diameters is line joining two points $(x_1, y_1)$ & $(x_2, y_2)$, Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$.Differential Calculus : Definition of function, limit and continuity, Simple problems on limit, Simple problems on continuity, Differentiation of $x^n$ , $e^x$ , sin x & cos x from first principle, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problems based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form y=f (x) (Simple problems based on it). Integral Calculus : Integration of simple functions, Integration of Product of two functions, Integration by substitution method, Definite Integral (simple problems based on it), Area under simple well-known curves (simple problems based on it). Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation.

**Math. 105 Calculus-I** **3+0** **Sem. II**

Precise definition of limit, continuity, one-sided limit, limits involving infinity, tangents and the derivative at a point, the derivative of a function, extreme values of functions, mean value theorem, monotone functions and the first derivative test, test for concavity. Definite integrals, area between curves, volumes using cross sections and cylindrical shells, arc length and areas of surfaces of revolution. Limits and continuity for functions of several variables, partial derivatives, the chain rule, directional derivatives, gradient vectors, tangent planes, extreme values and saddle points, Lagrange multipliers. Multiple Integrals Double integrals, triple integrals, Jacobian, substitutions in multiple integrals, Green's theorem, Stoke's theorem and the divergence's theorem.

**Math. 106 Introductory Mathematics** **2+0** **Sem. I**

Matrices, determinants and their applications to the solution of system of equations. Analytical geometry of two dimensions: equations of line and circle. Functions. Limit. Continuity, Differentiation. Simple integration.

**Math. 107 Fundamental Mathematics** **2+1** **Sem. I**

Trigonometry: addition and subtraction formulae, product and sum formulae. Binomial theorem. Matrices, determinants and their applications to the solution of system of equations. Analytical geometry of two dimensions: equations of line and circle. Functions. Limit. Continuity. Differentiation. Integration. Ordinary differential equations of first order and first degree, variable separable and homogeneous and Leibnitz linear differential equations.

**Practicals:** Tutorials on: trigonometry, binomial theorem, matrices, determinants, solution of system of equations, line, circle, limit, continuity, differentiation, integration and ordinary differential equations.

**Math. 201 Engineering Mathematics-I** **2+1** **Sem. I**

Matrices: Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, quadratic forms. PAQ form, Echelon form, Solution of linear equations, nature of rank, using Cayley-Hamilton theorem to find inverse of A. Differential calculus: Taylor's and Maclaurin's expansions; indeterminate form; curvature, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, maxima and minima. Integral calculus: volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume. Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; line, surface and volume integrals, Stoke's, divergence and Green's theorems (without proofs).

**Practicals :** Tutorials on rank of a matrix, reduction to normal form, consistency and solution of linear equations, eigen values and eigen vectors, Cayley-Hamilton theorem, diagonalization of matrices, quadratic forms; Taylor's and Maclaurin's expansion, indeterminate form, curvature, tracing of curves, partial differentiation, maxima and minima, volume and surface of revolution, multiple integrals, Beta and Gamma functions, differentiation of vectors, gradient, divergence and curl of a vector point function, line, surface and volume integrals, Stoke's divergence and Green's Theorems.

**Math. 202 Engineering Mathematics –II** **2+1** **Sem. II**

Ordinary differential equations- exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients. Series solution techniques, Bessel's and Legendre's differential equations. Functions of a complex variable- limit, continuity and analytic function, Cauchy-Riemann equations, harmonic functions. Infinite series and its convergence. Fourier series- periodic functions, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions,

half range series, harmonic analysis, Fourier sine and cosine series, fourier series for function having period 2L. Infinite series, convergence of infinite series, comparison test, integral test, D'Alembert's ratio test, Raabe's and logarithmic test, Cauchy root test. Partial differential equations- formation of partial differential equations, elimination of one and two arbitrary function, higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one dimensional wave and heat flow equations, Laplace Equation).

**Practicals :** Tutorials on solution of ordinary differential equations of first and higher orders. Series solutions of differential equations. Bessel's and Legendre's differential equations, Convergence of infinite series. Fourier series, harmonic analysis, analytical functions, Cauchy-Riemann equations, harmonic functions. Solution and application of partial differential equations.

**Math. 205 Higher Mathematics-I** **2+0** **Sem. I**

Differential calculus- Taylor's and Maclaurin's expansions, indeterminate form, curvature, asymptotes, tracing of curves, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivative, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima. Integral calculus- reduction formulae, rectification of standard curves, volumes and surfaces of revolution of curves, double and triple integrals, change of order of integration, gamma and beta functions, application of double and triple integrals to find area and volume. Ordinary differential equations- exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations. Vector calculus- differentiation of vectors, scalar and vector point functions, vector differential operator del, gradient of a scalar point function, divergence and curl of a vector point function and their physical interpretations, identities involving del, second order differential operator, line, surface and volume integrals, Stoke's, Divergence and Green's theorems.

**Math. 206 Higher Mathematics - II** **2+0** **Sem. II**

Matrices- elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, consistency and solution of linear equations, eigen values and eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, bilinear and quadratic forms. Functions of a complex variable-limit, continuity and derivative of complex functions, analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions. Fourier and infinite series- infinite series and its convergence, periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, harmonic analysis. Partial differential equations- formation of partial differential equations, Lagrange's linear equation, higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one-dimensional wave and heat flow equations, two-dimensional steady state heat flow equation (Laplace equation).

**Math. 207 Biomathematics** **2+1** **Sem. I**

Rolle's theorem, Lagrange's theorem, Taylor's and Maclaurin's series, partial differentiation, Euler's theorem on homogeneous functions, change of variable, Jacobian, maxima and minima of two or more than two variables, eigen values and eigen vectors of a matrix. Reduction formulae, definite integrals and its applications. Solution of ordinary differential equations of first degree and first order and their application for determination of volume of blood and drug distribution, epidemic models, simultaneous differential equations of first order and their applications to predator models, linear differential equations of higher order and their applications to simple biological problem. Numerical methods for solving algebraic and transcendental equations.

**Practicals :** Tutorials on Taylor's and Maclaurin's expansions, partial differentiation, Euler's theorem, change of variable, total derivative, implicit function, maxima and minima, eigen values and eigen vectors

of a matrix, reduction formulae, definite integrals and their properties, epidemic models, predator models, determination of volume of blood and drug distribution. Ordinary differential equations of first order, linear differential equations of higher order and their applications to biological problems, numerical methods.

**Math. 301 Engineering Mathematics- III** **2+1** **Sem. I**

Numerical analysis and Laplace transformation- finite difference, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, Bessel's and Stirling's difference interpolation formulae, interpolation with unequal intervals. Newton's divided difference formula, Lagrange's interpolation formula. numerical differentiation, numerical integration, difference equations and their solutions, numerical solutions of ordinary differential equations by Picard's method, Taylor's series method, Euler's and modified Euler's method, Runga-Kutta method. Laplace transformation and its applications to the solutions of ordinary and simultaneous differential equations. Testing of hypothesis-level of significance, degrees of freedom, statistical errors, large sample test (Z-test), small sample test t-test (one sample, two sample and paired test), testing of significance through variance (F-test), Chi -Square test, contingency table. Correlation. Regression.

**Practicals :** Interpolation, numerical differentiation and integration, solutions of difference equations, numerical solution of ordinary differential equations of first order and first degree, Laplace and inverse Laplace transformations and their application to solution of ordinary and simultaneous differential equations. Problems on one sample, two sample Z-tests when population S.D. is known and unknown. Problems on one sample, two sample and pairedt-test. Chi-Square test – 2×2 and m × n, contingency table, calculation of correlation coefficient and its testing and F-test.

## Undergraduate Elective/ M.Sc. Supporting/ Minor Courses:

**Math. 421 Fundamentals of Calculus** **2+0** **Sem.II**

Partial differentiation, maxima and minima of two or more variables, Lagrange's multipliers, implicit Function, Jacobian determinant and applications in error analysis. Integration, reduction formulae. Applications to find areas and volumes. Double integrals. Ordinary differential equations, complete solution of linear differential equations and particular solution by variation of parameters. Simultaneous linear differential equations. Application to simple economic models.

**Math. 422 Matrix Algebra** **2+0** **Sem. I**

Determinants and matrices, special types of matrices, algebraic operations, partitioning of matrices, rank of a matrix, rank of a product of matrices, inverse of a matrix by Gauss elimination, Gauss - Jordan, Crout's, Dolittle's and Cholesky's methods, bilinear, quadratic, Hermitian and skew Hermitian forms. Eigen values and eigen vectors of a matrix, bounds of eigen values and determination of eigen values by iterations. Solution of homogeneous and non-homogeneous system of linear equations using matrices.

**Math. 423 Elementary Calculus for Business Management** **2+0** **Sem.I**

Functions. Limit. Continuity. Differentiation, geometrical interpretation of dy/dx, successive Differentiation. Partial differentiation. Analytical optimization techniques. Integration and simple applications to management problems. Ordinary differential equations and their applications to management problems.

## Postgraduate courses

**Math.-501 Finite Element Methods** **2+1** **Sem.I**

**Unit I** Introduction. Historical background, Stress equilibrium, boundary condition,stress strain relation, potential energy and equilibrium. Rayleigh-Ritz method. Galerkin method.

**Unit II** Coordinates and shape functions, potential energy approach,element stiffness matrix,Galerkin approach, assembly of global stiffness matrix. The finite element equation, boundary conditions.

**Unit III** Trusses: Two dimensional problems, modeling by constant strain triangle, two dimensional iso parametric elements, the four-node quadrilateral.

**Unit IV** Scalar field problems, steady state heat transfer, torsion, potential flow, seepage and fluid flow index, dynamic analysis, principles.

**Practical:** Use of simple FEM software for FEM software for understanding, principles of FEM. Working out simple problems using LISA or any simple software with understanding of operation. Solving one dimensional problem. Solution to planar and spatial trusses, solving simple two-dimensional problems, Axisymmetric problems, solution of problems with two dimensional iso-parametric elements,solving simple beams and frames,three dimensional problems, solution to heat transfer problems and flow problems.

**Math.-502 Numerical Methods for Engineers** **2+1** **Sem.II**

**Unit I** Solution of Algebraic Equations: Solution of non-linear and transcendental equations in one or more than one variable using bisection, false position, iteration, Newton Raphson, Secant methods. Solution of linear simultaneous equations: Matrix inversion, Gauss elimination, Gauss Jordan, LU decomposition methods, ill-conditioned systems.

**Unit II** Solution of Ordinary Differential Equations: Initial Value Problem, Taylor series method, Picard's method, Euler method, Modified Euler method, RK class and predictor corrector class methods. Stiff ODE's and Gear's methods. Boundary Value Problem, Shooting methods, finite difference method. Use of Method of weighted residuals and orthogonal collocation and Galerkin technique to solve BVP in ODEs

**Unit III** Eigen values and Eigen vectors: Maximum and minimum eigenvalue by Power spectral and Inverse Power Method, all eigenvalues by Fadeev-Leverrier method. Introduction to diagonalization and QR Factorization. Approximation Theory.

**Unit IV** Finite difference formulae: Forward and backward differences, Richardson's extrapolation, interpolation formulae, polynomial forms, linear interpolation, Lagrange interpolation polynomial, Newton interpolation polynomial.

**Unit V** Solution of Partial Differential Equations: Classification of PDEs(Parabolic, elliptical and hyperbolic equation), Elliptical equations, standard five points formula, diagonal five-point formula. Solution of Laplace equation by Liebman's iteration method. Poisson's equation and its applications. Solution of parabolic equations by Bender–Schmidt method, Bender-Schmidt recurrence equation, Crank-Nicholson difference method.

**Practical:** Use of EXCEL Sheet and MATLAB: Application of EXCEL Sheet and MATLAB to solve the Engineering problems

**Math.-521 Algebra-I** **3+0** **Sem.I**

**Unit I** Review of basic concepts of groups with emphasis on exercises, permutation groups, even and odd permutations, conjugacy classes of permutations, alternating groups, simplicity of An, $n > 4$.

**Unit II** Cayley's theorem, direct products, fundamental theorem for finite abelian groups, Sylow theorems and their applications, finite Simple groups, groups of order $p^2$ ,pq (p and q primes).

**Unit III** Review of basic concepts of rings, polynomial rings, the ring of Guassian integers, factorization theory in integral domains, divisibility.

**Unit IV** Unique factorization domain (UFD), principal ideal domain (PID), Euclidian domain (ED) and their relationships.

**Unit V** Fields, examples, characteristic of a field, subfield and prime field of a field, field extension, the degree of a field extension, algebraic extensions and transcendental extensions.

**Math.-522 Complex Analysis** **3+0** **Sem. I**

**Unit I** Complex plane, geometric representation of complex numbers, joint equation of circle and straight line, conformal mapping, linear transformation and mapping by another functions.

**Unit II** Bilinear Transformations, Analytic functions, Cauchy-Riemann equations, Harmonic functions and Harmonic conjugates.

**Unit III** Power series, exponential and trigonometric functions, arg z, log z, az and their continuous branches, Rouche's Theorem, Maximum Modulus principle.

**Unit IV** Schwarz' Lemma, Taylor series and Laurent series. Singularities, Cauchy's residue theorem. Calculus of residues, Zeros and poles of meromorphic functions.

**Unit V** Argument Principle, complex integrals, Cauchy integral formula and evaluation of line integrals by complex integration.

**Math.-523 Algebra-II** **3+0** **Sem.II**

**Unit I** Definition and examples of vector spaces (over arbitrary fields), subspaces, direct sum of subspaces, linear dependence and independence, basis and dimensions.

**Unit II** Linear transformations, algebra of linear transformations, linear functions, dual spaces, matrix representation of a linear transformation, rank and nullity of a linear transformation, invariant subspaces.

**Unit III** Characteristic polynomial and minimal polynomial of a linear transformation, eigen values and eigenvectors of a linear transformation.

**Unit IV** Diagonalization and triangularization of a matrix Jordan canonical forms, bilinear forms, symmetric bilinear forms.

**Unit V** Sylvester's theorem, quadratic forms, Inner product spaces, Gram-Schmidt orthonormalization process.

**Math.-524 Ordinary and Partial Differential Equations** **3+0** **Sem.II**

**Unit I** Existence and Uniqueness of solution of first order equations. Boundary value problems and Strum-Liouville theory. ODE in more than 2-variables.

**Unit II** Series solution technique for the solution of linear ordinary differential equations of variable coefficients. Frobenius Method.

**Unit III** Bessel equation, Bessel and Neumann functions, Legendre equation, Legendre function, Legendre associated functions and their properties.

**Unit IV** Hermite, Laguerre equations and respective special functions. Orthogonal property of special functions, Partial differential equations of first order. Partial differential equations of higher order with constant coefficients.

**Unit V** Partial differential equations of second order and their classification. variable separable technique for the solution of heat equation, wave equation, Laplace equation.

**Math.-525 Elements of Functional Analysis** **2+0** **Sem. II**

**Unit I** Revision of vector spaces, inner product spaces and normed spaces.

**Unit II** Banach Spaces with examples of LP ( [a,b] ) and C ( [a,b] ), Hahn Banach theorem, open mapping theorem, closed graph theorem.

**Unit III** Baire Category theorem, Banach Steinhauns theorem (Uniform boundedness principle), Boundedness and continuity of linear transformation.

**Unit IV** Dual Spaces. Hilbert space, orthonormal basis, Bessel's inequality, Riesz Fischer theorem, Parseval's identity.

**Unit V** Bounded Linear functionals; projections, Riesz Representation theorem, adjoint operators, self adjoint, normal, Unitary and isometric operators.

**Math.-526 Numerical Methods** **2+1** **Sem. I**

**Unit I** Computational errors, absolute and relative errors, difference operators, divided differences, interpolating polynomials using finite differences.

**Unit II** Hermite interpolation, piecewise and spline interpolation, bivariate interpolation. Numerical solution of algebraic and transcendental equations by bisection, secant and Newton-Raphson Methods.

**Unit III** Solution of polynomial equations by Birge-Vieta, Bairstow's and Graffe's root squaring methods.

**Unit IV** Numerical Differentiation, Numerical Integration: General formulae, Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Romberg integration, Newton-Cotes formulae, Gaussian integration.

**Unit V** Solution of Ordinary Differential Equations: Taylor's series, Picard method of Successive approximations, Euler's method, Modified Euler's method, Runge-Kutta Method - 2nd and 4th order, Predictor-Corrector methods, Milne-Simpson's method, Adam's – Bashforth method, Finite difference method for boundary value problems.

**Practical :** Computational errors, absolute and relative errors, difference operators, divided differences, interpolating polynomials using finite differences, Hermite interpolation, piecewise and spline interpolation, bivariate interpolation, numerical solution of algebraic and transcendental equations by bisection, secant and Newton-Raphson methods, solution of polynomial equations by Birge-Vieta, Bairstow's and Graffe's root squaring methods, numerical differentiation, numerical integration: general formulae, trapezoidal rule, Simpson's 1/3 and 3/8 rule, Romberg integration, Newton-Cotes formulae, Gaussian integration, solution of ordinary differential equations: Taylor's series, Picard method of successive approximations, Euler's method, modified Euler's method, Runge-Kutta method - 2nd and 4th order, predictor-corrector methods, Milne-Simpson's method, Adam's – Bashforth method, finite difference method for boundary value problems.

**Math.-527 Calculus of Variation and Operations** **2+0** **Sem.I**

**Unit I** Functional and their properties, Motivating problems of Calculus of variations, Shortest distance, minimum surface of revolution.

**Unit II** Brachistochrone problem, Isoperimetric problems, Geodesics, Fundamental lemma of Calculus of Variations.

**Unit III** Euler's equation for one dependent function and its generalization to (i) n dependent functions, (ii) higher order derivatives.

**Unit IV** Variational problems with moving boundaries, Variation under constraints.

**Unit V** Variational methods of Rayleigh-Ritz and Galerkin.

**Math.-528 Real Analysis** **2+0** **Sem.I**

**Unit I** Basic Topology: Finite, countable and uncountable sets, Metric spaces, Perfect, compact and connected sets.

**Unit II** Sequences and series: Convergent sequences, Subsequences, Cauchy sequences (in metric spaces).

**Unit III** Absolute convergence. Continuity: Limits of functions (in metric spaces), Continuous and monotonic functions, Continuity and compactness, Continuity and connectedness.

**Unit IV** The Riemann-Stieltjes integral: Definition and properties of the Riemann-Stieltjes integral, Rectifiable curves.

**Unit V** Sequences and series of functions: Pointwise and Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Stone Weierstrass Theorem.

**Math.-529 Principles of Topology** **2+0** **Sem.I**

**Unit I** Connected sets, topological spaces, bases for a topology, the order topology, the product topology on $X \times Y$, the subspace topology.

**Unit II** Closed sets and limit points, continuous functions, the product topology, the metric topology, the quotient topology.

**Unit III** Compact spaces, compact space of the real line, limit point compactness, local compactness, nets, the countability axioms.

**Unit IV** Nets ,the countability axioms, The separation axioms, normal spaces

**Unit V** The Urysohn lemma, the Urysohnmetrization theorem, the Tietze extension theorem, the Tychonoff theorem.

**Math.-530 Transformation Theory** **2+0 Sem. II**

**Unit I** Laplace transformation, inverse Laplace transformation, applications. inverse Laplace transformation, Fourier transformation, convolution theorem .

**Unit II** Parseval's Identity, applications of transforms to boundary value problems, Z- transforms, definition of integral equations and their classifications.

**Unit III** Eigen values and Eigen functions, special kinds of kernel, Convolution integral, inner or scalar product of two functions, reduction to a system of algebraic equations.

**Unit IV** Fredholm alternative, Fredholm theorem, Fredholm alternative theorem, an approximate method, method of successive approximations.

**Unit V** Iterative scheme for Fredholm and Volterrra integral equations of the second kind, conditions of Uniform convergence and Uniqueness of series solution.

**Math.-531 Measure Theory** **2+0 Sem.I**

**Unit I** Lebesgue outer measure, measurable sets, Lebesgue measure, regularity of the Lebesgue measure, measurable functions.

**Unit II** Borel and Lebesgue measurability, a non-measurable set, Littlewood's three principles.

**Unit III** The Lebesgue integral: Integration of non-negative measurable functions, the general Lebesgue integral, monotone convergence theorem and dominated convergence theorem.

**Unit IV** Integration of series, relationship with Riemann integral.

**Unit V** Positive Borel measures: vector spaces, the Riesz representation theorem (statement only).

**Math.-532 Classical Mechanics** **2+0 Sem.II**

**Unit I** Variation under constraints, Variational methods of Rayleigh-Ritz and Galerkin. Lagrangian Mechanics: Generalized coordinates, Constraints, Holonomic and non-holonomic systems, Scleronomic and Rheonomic systems.

**Unit II** Generalized velocity, potential and force, Velocity dependent Potentials and Dissipation function.

**Unit III** Lagrangian Mechanics: Hamilton's principle, Principle of Least action, Cyclic coordinates, Conjugate momentum, Conservation theorems. Hamiltonian Mechanics: Legendre's transformation, Hamilton's equations, Routhian.

**Unit IV** Poisson Bracket, Jacobi identity for Poisson bracket, Poission theorem, Canonical Transformation.

**Unit V** Hamilton-Jacobi equations, Method of Separation of variables, Action – Angle variables, Lagrange Bracket.

**Math.-535 Operational Methods** **2+1 Sem.II**

**Unit I** Linear Programming and examples, Convex Sets, Hyperplane, Open and Closed half-spaces, Feasible, Basic Feasible and Optimal Solutions, Extreme Point & graphical methods, Simplex method, Charnes-M method, Two phase method, Determination of Optimal solutions, unrestricted variables.

**Unit II** Duality theory, Dual linear Programming Problems, fundamental properties of dual Problems, Complementary slackness, Unbounded solution in Primal. Dual Simplex Algorithm, Sensitivity analysis.

**Unit III** Cost minimization Transportation Problems, Balanced and unbalanced Transportation problems, U-V method, Paradox in Transportation problem.

**Unit IV** Time Minimization Transportation Problems, Cost Minimization and Time Minimization Assignment problems, Hungarian Method and its convergence.

**Unit V** Integer Programming problems: Pure and Mixed Integer Programming problems, Gomary's algorithm, Branch & Bound Technique, Travelling salesman problem.

**Practical :** Linear programming and examples, convex sets, hyperplane, open and closed half-spaces, feasible, basic feasible and optimal solutions, extreme point & graphical methods, simplex method, Charnes-m method, two phase method, determination of optimal solutions, unrestricted variables, duality theory, dual linear programming problems, fundamental properties of dual problems, complementary slackness, unbounded solution in primal, dual simplex algorithm, sensitivity analysis, cost minimization transportation problems, balanced and unbalanced transportation problems, u-v method, paradox in transportation problem, time minimization transportation problems, cost minimization and time minimization assignment problems, Hungarian method and its convergence, integer programming problems: pure and mixed integer programming problems, Gomary's algorithm, branch & bound technique, travelling salesman problem.

**Math.-533/Phys.-517 Mathematical Physics-I** **3+0** **Sem. I**

**Unit I** Laplace transform, its properties and its applications for the solution of differential equations. Fourier series, Fourier integral and its applications.

**Unit II** Series solution technique for the solution of linear ordinary differential equations of variable coefficients, Frobenius Method.

**Unit III** Bessel equation, properties of Bessel functions, Legendre equation, Legendre associated functions and their properties. Hermite, Laguerre and respective special functions.

**Unit IV** Complex integrals, Cauchy's integral theorem, Cauchy's integral formula and evaluation of line integral by complex integration**,** Taylor's and Laurant's series.

**Unit V** Integration by methods of residuals, Contour integration. Complex analytic function, potential theory and applications to two-dimensional fluid flow.

**Math.-534/Phys.-518 Mathematical Physics-II** **2+1** **Sem. II**

**Unit I** Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigen values and eigen vectors.

**Unit II** Linear ordinary differential equations of second & higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, Green's function as a solution technique for non-homogeneous ordinary differential equations.

**Unit III** Partial differential equations of first order, variable separable technique for the solution of heat equation, wave equation, Laplace equation.

**Unit IV** Numerical solution of algebraic and transcendental equations by bisection, secant and Newton-Raphson, Difference operators, divided differences, interpolating polynomials using finite differences, Numerical Integration: General formulae, Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods.

**Unit V** Introductory group theory, Transformation of co-ordinates. Indicial and summation conventions, covariant and contravariant vectors, invariant tensors.

**Practical :** Vector algebra and vector calculus, eigen values and eigen vectors, linear ordinary differential equations of second & higher orders, heat equation, wave equation, laplace equation, solution of first order differential equation, numerical solution of algebraic and transcendental equations, numerical integration, finite difference methods.

**Math.-591 Seminar** **1+0**

**Math.-599 Master's Research** **0+30**

## B) STATISTICS

### Undergraduate Courses

**Stat. 201 Elementary Statistics** **2+0 Sem. II**

Definition and scope of statistics, presentation and summarization of statistical data, frequency distribution, graphical presentation of data, measures of central tendency: mean, median, mode, geometric mean, harmonic mean. measures of dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, test of significance; Z-test for mean(s), t-test for mean(s), Chi- square test: goodness of fit test, contingency tables, correlation: Karl Pearson, Spearman's rank correlation, linear regression analysis, analysis of variance (ANOVA):one way ANOVA, elementary ideas about sampling.

**Stat. 205 Statistical Methods and Numerical Analysis** **2+1 Sem. I**

Frequency distribution and frequency curves. Measures of central tendency, Measures of dispersion. Normal distribution and its application. Introduction to sampling. Statistical methods, testing of hypothesis, concepts, testing of significance based on Z-test, t-test, F-test, Chi-square test, contingency table, correlation, regression, testing of significance of correlation and regression. ANOVA-one-way and two-way classifications, factorial experiment concepts ($2^2$, $2^3$). Numerical analysis - finite differences, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, numerical integration by Trapezoidal, Simpson's rules. Numerical solution of ordinary differential equations, Runge-Kutta method. Laplace transforms-definition of Laplace transform, properties of Laplace transforms, inverse Laplace transforms, transforms of derivatives, integrals, transform of function multiplied by $t^n$, transform of function divided by t, application of Laplace transforms to solve ordinary differential equations. Experimental designs- basic designs, completely randomized design (CRD) - layout and analysis with equal and unequal number of observations, randomized block design (RBD) - layout and analysis, Latin square design (LSD) – layout and analysis

**Practicals** : Problems on one sample, two sample Z-tests when population S.D. is known and unknown. Problems on one sample, two sample and paired t-test. Chi-square test – 2×2 and m×n contingency table and F-test. Calculation of correlation coefficient and its testing. Fitting of simple linear regression. ANOVA-one way/two way, $2^2$, $2^3$. Problems on Newton's forward and backward interpolation formula for equal intervals. Problems on trapezoidal rule, Problems on Simpson's 1/3 and 3/8 rules. Problems on solution of ordinary differential equations of first order and second orders by Runge-Kutta method. Problems on Laplace transforms. Problems on inverse transformations. Problems on solutions of first order differential equations.

**Stat. 206 Basic Statistics** **1+1 Sem. II**

Definition of statistics, its use and limitations. Frequency distribution and frequency curve and cumulative frequency curve. Measures of central tendency. Measures of dispersion. Probability- definition, additive and multiplicative law for two events. Normal distribution and its properties. Introduction to sampling. Sampling techniques. Tests of significance- null hypothesis, alternate hypothesis, type I & II error, one and two tail tests, level of significance and confidence interval. SND test for means. Single sample and two samples Z-test. Student's t-test for means, single sample, two samples and paired t-test, F-test. Chi-square test in 2x2 contingency table, Yate's correction for continuity. Correlation- scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing. Linear regression and its properties. Analysis of variance and its assumptions, analysis of CRD ,RBD and Latin square designs.

**Practicals :** Construction of frequency distribution tables and frequency curves. Computation of arithmetic- mean, median, mode. standard deviation, variance and coefficient of variation for ungrouped and grouped data. SND test for means, Student's t-test, F-test . Chi-square test. Correlation coefficient 'r' and its testing. Fitting of regression equations. Analysis of CRD, RBD, LSD.

**Stat. 207 Principles of Statistics** **2+1 Sem. I**

Introduction to statistics, uses and limitations. Qualitative and quantitative classification of data, discrete and continuous variables, frequency tables, grouped and ungrouped data. Diagrammatic representation

of data. Graphical representation of data -histogram, frequency polygon, frequency curve, ogives. Measures of central tendency (AM, GM, HM, median. mode with merits, demerits and uses). Measures of dispersion-range coefficients, inter quartile range, quartile deviation, coefficient of quartile deviation, mean deviation from mean, median and mode, variance, standard deviation, coefficient of variation. Moments. Measures of skewness and kurtosis. Probability theory- definition of probability and its laws. Definition of random variable, discrete and continuous random variables, probability distribution of random variable, basic concept of binomial distribution, Poisson distribution, normal distribution and its applications. Correlation and linear regression analysis. Tests of significance - basic definitions null and alternative hypothesis, tests statistic, testing of hypothesis, one sample and two sample Z & t-tests. Chi-square test of goodness of fit and Chi-square test of independence of attributes. Analysis of variance definition and analysis of one way classified data. Introduction to sampling methods- definition of population, random sample, sampling versus complete enumeration, use of random number table for selecting a simple random sample, simple random sampling with and without replacements.

**Practicals :** Graphical representation of data. Diagrammatic representation of data. Measures of central tendency (ungrouped and grouped data) with calculation of quartiles, deciles and percentiles. Measures of dispersion (ungrouped and grouped data). Moments- measures of skewness and kurtosis (ungrouped and grouped data). Correlation and regression analysis. Application of one sample and two sample Z-test and Fisher's t-test . Chi-square test of goodness of fit. Chi-square test of independence of attributes. Analysis of variance one way classification .Selection of random sample using simple random sampling.

**Stat. 208 Business Statistics** **2+1** **Sem. II**

Introduction to Sampling Theory, Sampling versus Complete Enumeration, Methods of Sampling: Probability sampling design —Simple Random Sampling (WR & WOR), Use of Random Number Tables for selection of Simple Random Sample. Concept of Stratified Sampling, Concept of Systematic sampling, Cluster, Multistage and Probability Proportional to Size (PPS) sampling along with their advantage & disadvantages. Non-probability sampling scheme: Judgment, convenience, quota and accident sampling scheme. Time series analysis: Introduction, Spatial, temporal and conditional series, Objectives of time series, components of time series: Trend, Seasonal, Cyclical and Irregular components. Measurement of trend: Graphical, Semi-Average, Moving Averages and Central Moving Averages, Isolation of trend by moving averages, Ordinary Least Squares (OLS), and fitting of trend. Index numbers: Concept & Definition, objectives of index numbers, advantages and limitations. Prerequisites of index numbers, Types of Index numbers: Price index number(retail and whole sale), Quantity index numbers, Value index numbers. Construction of Simple index numbers under simple aggregative& simple average of relatives (fixed and chain based) method. Construction of weighted index numbers under weighted aggregative method. Chain index number, conversion of chain base index number to fixed base index number, fixed base index number to chain base index number. Statistical Quality Control: Definition of control charts, uses of control charts, chance and assignable causes, parts of control charts (central line and control limits). Control charts for variables X-bar and R charts, control charts for fraction defective (p) and control charts for number of defects per unit ©. Operating characteristic curves for control charts.

**Practicals :** Use of Random Number Tables for selection of Simple Random Sample (WR/WOR). Computing Mean and Variance for Simple random samples. Determining sample size for Simple Random samples. Graphical presentation of various time-series components. Presenting trend line using Graphical and Semi-Average methods. Computation of Moving Average & Central Moving Average, Isolation of trend by moving averages. Fitting of trend line using Ordinary Least Squares (OLS). Construction of Price index number: Retail and Whole sale. Construction of Quantity index numbers and Value index numbers. Construction of Simple index numbers under simple aggregative & simple average of relatives (fixed and chain based) method. Construction of weighted index numbers under weighted aggregative method. Construction of Chain index number, conversion of chain base index number to fixed base index number, fixed base index number to chain base index number. Construction of X bar and R charts for variables. Construction of fraction defective (p) and number of defects per unit ©.Construction of Operating characteristic curves for control charts.

**Stat. 302 Fundamentals of Biostatistics** **2+1 Sem. II**

Random variables- expected value and its variance. Probability distribution of random variables, conditional probability, Baye's theorem and its applications. Introduction to uniform, binomial, Poisson, normal, exponential and gamma probability distributions. Random mating populations, Hardy-Weinberg Law. Introduction to Poisson process and Markov chains, transition probability matrix, n-step transition probabilities, steady states, random walk models, sensitivity and specificity. Chi-square test- testing heterogeneity, use in genetic experiment, detection of linkage, linkage ratios and its estimation. Analysis of variance- One-way and two-way classification with interaction. Analysis of covariance. Incomplete block designs. Estimation and significance of genotypic and phenotypic variation.

**Practicals :** Expected value and variance of discrete and continuous distributions- uniform, binomial, Poisson, normal, exponential and gamma probability distributions. Hardy-Weinberg law. Construction of transition probability matrix in Markov chains. Calculation of sensitivity and specificity. Detection and linkage using Chi-square test. One-way and two-way analysis of variance. Analysis of covariance. Incomplete block designs. Testing of heritability.

## Undergraduate Elective/M.Sc. Supporting/Minor Courses:

**Stat.-501 Mathematics for Applied Sciences** **2+0 Sem. I**

**Unit I** Set theory-set operations, finite and infinite sets, operations of set, function.

**Unit II** Vectors and vector spaces, Matrices notations and operations, laws ofmatrix algebra; transpose and inverse of matrix, Eigen values and Eigen vectors. Determinants - evaluation and properties of determinants, Solutions of Linear Equations.

**Unit III** Variables and functions, limits and continuity of specific functions. Differentiation: theorems of differentiation, differentiation of logarithmic, trigonometric, exponential and inverse functions, Differentiation of function of a function, derivatives of higher order, partial derivatives. Application of derivatives, determination of points of inflexion, maxima and minima.

**Unit IV** Integration, methods of integration, reduction formulae, definite and indefinite integral, Applications of integration in Agriculture, Differential Equations.

**Stat.-502 Statistical Methods For Applied Sciences** **2+1 Sem. I/II**

**Unit I** Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

**Unit II** Discrete and continuous probability distributions, Binomial, Poisson, Normal distribution. Determination of sample size. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions

**Unit III** Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

**Unit IV** Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Transformation of Data. Non-parametric tests - Run test for the randomness of a sequence, Median test, sign test, Wilcoxon sign rank test, Mann-Whitney U-test, Kruskal-Walli's one way and Friedman's two way ANOVA by ranks. Kendall's Coefficient of concordance.

**Practical :** Exploratory data analysis, fitting of distributions ~ binomial, Poisson, normal. Testing of hypothesis based on exact sampling distributions, large sample tests, t and f; confidence interval estimation and Chi square, anova: one way, two way, sampling theory, correlation and regression analysis, fitting of linear and quadratic model, non- parametric tests - run test for the randomness of a sequence, median test, sign test, Wilcoxon sign rank test, Mann-Whitney u-test, Kruskal-Walli's one way and Friedman's two way anova by ranks. Kendall's coefficient of concordance.

**Stat.-511 Experimental Designs** **2+1 Sem. II**

**Unit I** Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

**Unit II** Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.

**Unit III** Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

**Unit IV** Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs;Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

**Practical :** Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, analysis of data obtained from CRD, RBD, LSD, analysis of factorial experiments, analysis with missing data, split plot and strip plot designs.

**Stat.-512 BasicSampling Techniques** **2+1 Sem. II**

**Unit I** Concept of sampling, sample survey vs complete enumeration, planningof sample survey, sampling from a finite population.

**Unit II** Simple random sampling with and without replacement, sampling for proportion, determination of sample size, inverse sampling, Stratified sampling.

**Unit III** Cluster sampling, Multi-stage sampling, systematic sampling; Introduction to PPS sampling.

**Unit IV** Use of auxiliary information at estimation, Ratio product and regressionestimators. Double Sampling, sampling and non-sampling errors.

**Practical :** Random sampling ~ use of random number tables, concepts of unbiasedness, variance, etc., simple random sampling, determination of sample size, inverse sampling, stratified sampling, cluster sampling and systematic sampling, estimation using ratio and regression estimators, estimation using multistage design, double sampling.

**Stat.-521 Applied Regression Analysis** **2+1 Sem. I**

**Unit I** Introduction to correlation analysis and its measures, Correlation fromgrouped data, correlation, Rank correlation, Testing of population correlation coefficients; Multiple and partial correlation coefficients and their testing.

**Unit II** Problem of correlated errors; Auto correlation; Heteroscedastic models, Durbin Watson Statistics; Removal of auto correlation by transformation; Analysis of collinear data; Detection and correction of multi collinearity, Regression analysis; Method of least squares for curve fitting; Testing of regression coefficients; Multiple and partial regressions.

**Unit III** Diagnostic of multiple regression equation; Concept of weighted least squares; regression equation on grouped data; Various methods of selecting the best regression equation.

**Unit IV** Concept of nonlinear regression and fitting of quadratic, exponential and power curves; Economic and optimal dose, Orthogonal polynomial.

**Practical :** Correlation coefficient, various types of correlation coefficients and its testing, testing of hypotheses; multiple linear regression analysis, partial regression coefficients residuals and their applications in outlier detection; handling of correlated errors, multi-collinearity, fitting of quadratic, exponential and power curves, fitting of orthogonal polynomials.

**Stat.-522 Data Analysis Using Statistical Packages** **2+1 Sem. I**

**Unit I** Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data,Exploratory data analysis.

**Unit II** Test for normality; Testing of hypothesis using chi-square, *t* and *F* statistics and *Z*-test.

**Unit III** Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

**Unit IV** Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.

**Unit V** Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.

**Practical :** Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data, testing the hypothesis for one sample *t*-test, two sample *t*-test, paired *t*-test, testfor large samples - Chi-squares test, f test, one-way analysis of variance, designs for factorial experiments, fixed effect models, random effectmodels, mixed effect models, estimation of variance components, linear regression, multiple regression, regression plots, discriminant analysis - fitting of discriminant functions, identification of important variables, factor analysis, principal component analysis - obtaining principal component.

**Stat.-526 Non-Parametric Statistics** **2+1** **Sem. II**

**Unit I** Parametric versus non-parametric tests, hypothesis testing , scales of measurements, current tests of hypotheses when distribution is not specified, Binomial test, Chi-square one-sample test, Kolmogorov-Smirnov one sample test, One-sample run test

**Unit II** McNemar test, sign test, Median test, Wilcoxon matched-pairs signed-ranks test & the Randomization test & Fisher exact probability test, Chi-square test for two independent samples, The Mann-Whiteny U test, Kolmogorov-Smirnov test

**Unit III** Randomization test, Siegel Tukey test & permutation test, Cochran Q test, Friedman two-way ANOVA by ranks & page ordered test, extension of the median test & Jonckheere test, Kruskal-Wallis one-way ANOVA by ranks

**Unit IV** The Chi-square test for *k* independent samples & contingency coefficient *C,* Spearman rank, Kendall's partial tau statistic, Kendall rank correlation coefficient, W, U & $T_c$ tests, application in biological and sociological work.

**Practical :** One sample- Binomial and Chi- square tests, sign test and Wilcoxon sign rank test, median test, run test, two sample: Fisher's exact test, Wilcoxon, Mann- Whitney test, Kolmogorov, Smirnov test; k- sample, Kruskal–Wallis one way analysis by ranks, Friedman's two way analysis by ranks, Kendall's coefficient of concordance, Kendall's partial tau statistics.

## Postgraduate Courses

**Stat.-551 Mathematics-I** **3+0** **Sem. I**

**Unit I** Calculus: Limit and continuity, differentiation of functions, successive differentiation, partial differentiation, mean value theorems, Taylor and Maclaurin's series. Application of derivatives, L'hospital's rule.

**Unit II** Real Analysis: Convergence and divergence of infinite series, use of comparison tests -D'Alembert's Ratio - test, Cauchy's nth root test, Raabe's test, Kummer's test, Gauss test. Absolute and conditional convergence. Riemann integration, concept of Lebesgue integration, power series, Fourier, Laplace and Laplace -Steiltjes' transformation, multiple integrals. Integration of rational, irrational and trigonometric functions. Application of integration.

**Unit III** Differential equation: Differential equations of first order, lineardifferential equations of higher order with constant coefficient.

**Unit IV** Numerical Analysis: Simple interpolation, Divided differences, Numerical differentiation and integration.

**Stat.-552 Probability Theory** **2+0** **Sem. I**

**Unit I** Basic concepts of probability. Elements of measure theory: class of sets, field, sigma field, minimal sigma field, Borel sigma field in R, measure- probability measure. Axiomatic approach to

probability. Properties of probability based on axiomatic definition. Addition and multiplication theorems. Conditional probability and independence of events. Bayes theorem.

**Unit II** Random variables: definition of random variable, discrete and continuous, functions of random variables. Probability mass function and Probability density function, Distribution function and its properties. Notion of bivariate random variables, bivariate distribution function and its properties. Joint, marginal and conditional distributions. Independence of random variables. Transformation of random variables (two dimensional case only). Mathematical expectation: Mathematical expectation of functions of a random variable. Raw and central moments and their relation, covariance, skewness and kurtosis. Addition and multiplication theorems of expectation. Definition of moment generating function, cumulating generating function, probability generating function and statements of their properties.

**Unit III** Conditional expectation and conditional variance. Characteristic function and its properties. Inversion and Uniqueness theorems. Chebyshev, Markov, Cauchy-Schwartz, Sequence of random variables and modes of convergence (convergence in distribution in probability, almost surely, and quadratic mean) and their interrelations.

**Unit IV** Laws of large numbers: WLLN, Bernoulli and Kintchin's WLLN. Kolmogorov inequality, Kolmogorov's SLLNs. Central Limit theorems: Demoviere- Laplace CLT, Lindberg – Levy CLT and simple applications.

**Stat.-553 Statistical Methods** **2+1** **Sem. I**

**Unit I** Descriptive statistics: probability distributions: Discrete probability distributions ~Bernoulli, Binomial, Poisson, Negative-binomial, Geometric and Hyper Geometric, Uniform, multinomial ~ Properties ofthese distributions and real life examples. Continuous probabilitydistributions ~ rectangular, exponential, Cauchy, normal, gamma, beta oftwo kinds, Weibull, lognormal, logistic, Pareto. Properties of thesedistributions. Probability distributions of functions of random variables.

**Unit II** Concepts of compound, truncated and mixture distributions (definitions and examples). Sampling distributions of sample mean and sample variance from Normal population, central and non–central chi-Square, *t* and *F* distributions, their properties and inter relationships.

**Unit III**

Concepts of random vectors, moments and their distributions. Bivariate Normal distribution - marginal and conditional distributions. Distribution of quadratic forms. Cochran theorem. Correlation, rank correlation, correlation ratio and intra-class correlation. Regression analysis, partial and multiple correlation and regression.

**Unit IV** Sampling distribution of correlation coefficient, regression coefficient. Categorical data analysis, Association between attributes. Variance Stabilizing Transformations.

**Unit V** Order statistics, distribution of *r*-th order statistics, joint distribution of several order statistics and their functions, marginal distributions of order statistics.

**Practical :** Fitting of discrete distributions and test for goodness of fit, fitting of continuous distributions and test for goodness of fit, fitting of truncated distribution, computation of simple, multiple and partial correlation coefficient, correlation ratio and intra-class correlation, regression coefficients and regression equations, fitting of Pearsonian curves, analysis of association between attributes, categorical data and log-linear models.

**Stat.-554 Actuarial Statistics** **2+0** **Sem. I**

**Unit I** Insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality.

**Unit II** Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.

**Unit III** Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.

**Unit IV** Distribution of aggregate claims, compound Poisson distribution and its applications.

**Unit V** Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

**Unit VI** Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions.

**Unit VII** Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportionable annuities-due.

**Unit VIII** Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.

**Unit IX** Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses. Claim amount distributions, approximating the individual model, stop-loss insurance.

**Stat.-555 Bioinformatics** **2+0** **Sem. I**

**Unit I** Basic Biology: Cell, genes, gene structures, gene expression and regulation, Molecular tools, nucleotides, nucleic acids, markers, proteins and enzymes, bioenergetics, single nucleotide polymorphism, expressed sequence tag. Structural and functional genomics: Organization and structure of genomes, genome mapping, assembling of physical maps, strategies and techniques for genome sequencing and analysis.

**Unit II** Computing techniques: OS and Programming Languages – *Linux, perl*, *bioperl*, *python, biopython*, *cgi*, *My SQL*, *php My Admin*; Coding for browsing biological databases on web, parsing & annotation of genomic sequences; Database designing; Computer networks – Internet, World wide web, Web browsers– EMB net, NCBI; Databases on public domain pertaining to Nucleic acid sequences, protein sequences, SNPs, etc.; Searching sequence databases, Structural databases.

**Unit III** Statistical Techniques: MANOVA, Cluster analysis, Discriminant analysis, Principal component analysis, Principal coordinate analysis, Multidimensional scaling; Multiple regression analysis; Likelihood approach in estimation and testing; Resampling techniques – Bootstrapping and Jack-knifing; Hidden Markov Models; Bayesian estimation and Gibbs sampling;

**Unit IV** Tools for Bioinformatics: DNA Sequence Analysis – Features of DNA sequence analysis, Approaches to EST analysis; Pairwise alignment techniques: Comparing two sequences, PAM and BLOSUM, Global alignment (The Needleman and Wunsch algorithm), Local Alignment (The Smith-Waterman algorithm), Dynamic programming, Pairwise database searching; Sequence analysis– BLAST and other related tools, Multiple alignment and database search using motif models, Clustal W, Phylogeny; Databases on SNPs; EM algorithm and other methods to discover common motifs in biosequences; Gene prediction based on Neural Networks, Genetic algorithms, Computational analysis of protein sequence, structure and function; Design and Analysis of microarray/RNA seq experiments.

**Stat.-556 Econometrics** **2+0** **Sem. I**

**Unit I** Representation of Economic phenomenon, relationship among economic variables, linear and non-linear economic models, single equation general linear regression model, basic assumptions, Ordinary least squares method of estimation for simple and multiple regression models; summary statistics correlation matrix, co-efficient of multiple determination, standard errors of estimated parameters, tests of significance and confidence interval estimation. BLUE properties of Least Squares estimates. Chow test, test of improvement of fit through additional regressors. Maximum likelihood estimation.

**Unit II** Heteroscedasticity, Auto-correlation, Durbin Watson test, Multi- collinearity. Stochastic regressors, Errors in variables, Use of instrumental variables in regression analysis. Dummy Variables. Distributed Lag models: Koyck's Geometric Lag scheme, Adaptive Expectation and Partial Adjustment Mode, Rational Expectation Models and test for rationality.

**Unit III** Simultaneous equation model: Basic rationale, Consequences of simultaneous relations, Identification problem, Conditions of Identification, Indirect Least Squares, Two-stage least squares, K-class estimators, Limited Information and Full Information Maximum Likelihood Methods, three stage least squares, Generalized least squares, Recursive models, SURE Models. Mixed Estimation Methods, use of instrumental variables, pooling of cross-section and time series data, Principal Component Methods.

**Unit IV** Problem and Construction of index numbers and their tests; fixed and chain based index numbers; Construction of cost of living index number.

**Unit V** Demand analysis – Demand and Supply Curves; Determination of demand curves from market data. Engel's Law and the Engel's Curves, Income distribution and method of its estimation, Pareto's Curve, Incomeinequality measures.

**Stat.-561 Mathematics-II** **2+0 Sem. II**

**Unit I** Linear Algebra: Group, ring, field and vector spaces, Sub-spaces, basis, Gram Schmidt's orthogonalization, Galois field - Fermat's theorem and primitive elements. Linear transformations. Graph theory: Concepts and applications.

**Unit II** Matrix Algebra: Basic terminology, linear independence and dependence of vectors. Row and column spaces, Echelon form. Determinants, Trace of matrices rank and inverse of matrices. Special matrices – idempotent, symmetric, orthogonal. Eigen values and eigen vectors, Spectral decomposition of matrices.

**Unit III** Unitary, Similar, Hadamard, Circulant, Helmert's matrices. Kronecker and Hadamard product of matrices, Kronecker sum of matrices. Sub- matrices and partitioned matrices, Permutation matrices, full rank factorization, Grammian root of a symmetric matrix. Solutions of linear equations, Equations having many solutions.

**Unit IV** Generalized inverses, Moore-Penrose inverse, Applications of g-inverse. Inverse and Generalized inverse of partitioned matrices, Differentiation and integration of vectors and matrices, Quadratic forms.

**Stat.-562 Statistical Inference** **2+1 Sem. II**

**Unit I** Concepts of point estimation: unbiasedness, consistency, efficiency and sufficiency. Statement of Neyman's Factorization theorem with applications. MVUE, Rao-Blackwell theorem, completeness, Lehmann-Scheffe theorem. Fisher information, Cramer-Rao lower bound and itsapplications.

**Unit II** Moments, minimum chi-square, least square and maximum likelihood methods of estimation and their properties. Interval estimation-Confidence level, shortest length CI. CI for the parameters of Normal, Exponential, Binomial and Poisson distributions.

**Unit III** Fundamentals of hypothesis testing-statistical hypothesis, statistical test, critical region, types of errors, test function, randomized and non- randomized tests, level of significance, power function, most powerful tests: Neyman-Pearson fundamental lemma, MLR families and UMP tests for one parameter exponential families. Concepts of consistency, unbiasedness and invariance of tests. Likelihood Ratio tests, asymptotic properties of LR tests with applications (including homogeneity of means and variances). Relation between confidence interval estimation andtesting of hypothesis.

**Unit IV** Sequential Probability ratio test, Properties of SPRT. Termination property of SPRT, SPRT for Binomial, Poisson, Normal and Exponential distributions. Concepts of loss, risk and decision functions, admissible and optimal decision functions, estimation and testing viewed as decision problems, conjugate families, Bayes and Minimax decision functions with applications to estimation with quadratic loss.

**Unit V** Non-parametric tests: Sign test, Wilcoxon signed rank test, Runs test for randomness, Kolmogorov – Smirnov test for goodness of fit, Median test and Wilcoxon-Mann-Whitney U-test. Chi-square test for goodness of fit and test for independence of attributes. Spearman's rank correlation and Kendall's Tau tests for independence.

**Practical :** Methods of estimation - maximum likelihood, minimum $t^2$ and moments, confidence interval estimation, mp and ump tests, large sample tests, non-parametric tests, sequential probability ratio test, decision functions.

**Stat.-563 Design Of Experiments** **2+1** **Sem. II**

**Unit I** Elements of linear estimation, Gauss Markoff Theorem, relationship between BLUEs and linear zero-functions. Aitken's transformation, test of hypothesis, Analysis of Variance, partitioning of degrees of freedom.

**Unit II** Orthogonality, contrasts, mutually orthogonal contrasts, analysis of covariance; Basic principles of design of experiments, Uniformity trials, size and shape of plots and blocks, Randomization procedure.

**Unit III** Basic designs - completely randomized design, randomized complete block design and Latin square design; Construction of orthogonal Latin squares, mutually orthogonal Latin squares (MOLS), Youden square designs, Graeco Latin squares.

**Unit IV** Balanced incomplete block (BIB) designs – general properties and analysis without and with recovery of intra block information, construction of BIB designs. Partially balanced incomplete block designs with twoassociate classes - properties, analysis and construction, Lattice designs, alpha designs, cyclic designs, augmented designs.

**Unit V** Factorial experiments, confounding in symmetrical factorial experiments ($2^n$and $3^n$series), partial and total confounding, asymmetrical factorials.

**Unit VI** Cross-over designs. Missing plot technique; Split plot and Strip plot design; Groups of experiments. Sampling in field experiments.

**Practical :** Determination of size and shape of plots and blocks from uniformity trials data, analysis of data generated from completely randomized design, randomized complete block design, latin square design, Youden square design, analysis of data generated from a bib design, lattice design, pbib designs; $2^n$, $3^n$ factorial experiments without and with confounding, split and strip plot designs, repeated measurement design, missing plot techniques, analysis of covariance, analysis of groups of experiments, analysis of clinical trial experiments.

**Stat.-564 Sampling Techniques** **2+1** **Sem. I**

**Unit I** Sample survey vs complete enumeration, probability sampling, sample space, sampling design, sampling strategy; Determination of sample size; Confidence-interval; Simple random sampling, Estimation of population proportion, Stratified random sampling, Proportional allocation and optimal allocation, Inverse sampling.

**Unit II** Ratio, Product and regression methods of estimation, Cluster sampling, Systematic sampling, Multistage sampling with equal probability, Separate and combined ratio estimator, Double sampling, Successive sampling –two occasions. Unbiased ratio type estimators

**Unit III** Non-sampling errors – sources and classification, Non-response in surveys, Randomized response techniques, Response errors/Measurement error – interpenetrating sub-sampling.

**Unit IV** PPS Sampling with and without replacement, Cumulative method and Lahiri's method of selection, Horvitz-Thompson estimator, Ordered and unordered estimators, Sampling strategies due to Midzuno-Sen and Rao- Hartley-Cochran. Inclusion probability proportional to size sampling.

**Practical :** Determination of sample size and selection of sample, simple random sampling, inverse sampling, stratified random sampling, cluster sampling, systematic sampling, ratio and regression methods of estimation, double sampling, multi-stage sampling, imputation methods; randomized response techniques; sampling with varying probabilities.

**Stat.-565 Statistical Genetics** **2+1** **Sem. II**

**Unit I** Physical basis of inheritance. Analysis of segregation, detection and estimation of linkage for qualitative characters. Amount of information about linkage, combined estimation, disturbed segregation.

**Unit II** Gene and genotypic frequencies, Random mating and Hardy -Weinberg law, Application and extension of the equilibrium law, Fisher's fundamental theorem of natural selection. Disequilibrium due to linkagefor two pairs of genes, sex-linked genes, Theory of path coefficients.

**Unit III** Concepts of inbreeding, Regular system of inbreeding. Forces affecting gene frequency - selection, mutation and migration, equilibrium between forces in large populations, Random genetic drift, Effect of finite population size.

**Unit IV** Polygenic system for quantitative characters, concepts of breeding value and dominance deviation. Genetic variance and its partitioning, Effect of inbreeding on quantitative characters, Multiple allelism in continuous variation, Sex-linked genes, Maternal effects - estimation of theircontribution.

**Unit V** Correlations between relatives, Heritability, Repeatability and Genetic correlation. Response due to selection, Selection index and its applications in plants and animals' improvement programmes, Correlated response to selection.

**Unit VI** Restricted selection index. Variance component approach and linear regression approach for the analysis of GE interactions. Measurement of stability and adaptability for genotypes. Concepts of general and specific combining ability. Diallel and partial diallel crosses - construction and analysis.

**Practical :** Test for the single factor segregation ratios, homogeneity of the families with regard to single factor segregation, detection and estimation of linkage parameter by different procedures, estimation of genotypic and gene frequency from a given data, Hardy-Weinberg law; estimation of changes in gene frequency due to systematic forces, inbreeding coefficient, genetic components of variation, heritability and repeatability coefficient, genetic correlation coefficient, examination of effect of linkage, epistasis and inbreeding on mean and variance of metric traits, mating designs; construction of selection index including phenotypic index, restricted selection index, correlated response to selection.

**Stat.-566 Statistical Quality Control** **2+0** **Sem. II**

**Unit I** Introduction to Statistical Quality Control; Control Charts for Variables – Mean, Standard deviation and Range charts; Statistical basis; Rationalsubgroups.

**Unit II** Control charts for attributes- 'np', 'p' and 'c' charts.

**Unit III** Fundamental concepts of acceptance, sampling plans, single, double and sequential sampling plans for attributes inspection.

**Unit IV** Sampling inspection tables for selection of single and double sampling plans.

**Stat.-567 Optimization Techniques** **1+1** **Sem. II**

**Unit I** Classification of optimization problems, Classical optimization techniques: single variable optimization, multivariable optimization techniques with no constraints, multivariable optimization techniques with equality constraints, multivariable optimization techniques with inequality constraints.

**Unit II** Linear programming: simplex method, duality, sensitivity analysis, Karmarkar's method, transportation problem.

**Unit III** Nonlinear programming Unconstrained optimization techniques: direct search methods such as random search, grid search, Hooke and Jeeves' method, Powel's method. Descent methods such as gradient method, steepest descent method, conjugate gradient method, Newton's method, Marquardt method.

**Unit IV** Quadratic programming, integer linear programming, integer nonlinear programming, geometric programming, dynamic programming, stochastic programming, multiobjective optimization, optimal control theory, genetic algorithms, simulated annealing, neural network based optimization

**Practical :** Problems based on classical optimization techniques, optimization techniques with constraints, minimization problems using numerical methods, linear programming (lp) problems through graphical method, simplex method, simplex two-phase method, primal and dual method, sensitivity analysis for lp problem, lp problem using Karmarkar's method, problems based on quadratic programming, integer programming, dynamic programming, stochastic programming, problems based on pontryagin's maximum principle, problems based on multi objective optimization.

**Stat.-571 Multivariate Analysis** **2+1** **Sem. I**

**Unit I** Concept of random vector, its expectation and Variance-Covariance matrix. Marginal and joint distributions. Conditional distributions and Independence of random vectors. Multinomial distribution. Multivariate Normal distribution, marginal and conditional distributions. Sample mean vector and its distribution. Maximum likelihood estimates of mean vector and dispersion matrix. Tests of hypothesis about mean vector.

**Unit II** Wishart distribution and its simple properties. Hotelling's T2 and Mahalanobis D2 statistics. Null distribution of Hotelling's T2. Rao's U statistics and its distribution. Wilks' λ criterion and its properties. Concepts of discriminant analysis, computation of linear discriminant function, classification between k ( ≥2) multivariate normal populations based on LDF and MahalanobisD2.

**Unit III** Principal Component Analysis, factor analysis. Canonical variables and canonical correlations. Cluster analysis: similarities and dissimilarities of qualitative and quantitative characteristics, Hierarchical clustering. Single, Complete and Average linkage methods. K-means cluster analysis.

**Unit IV** Path analysis and computation of path coefficients, introduction to multidimensional scaling, some theoretical results, similarities, metric and non-metric scaling methods.

**Practical :** Maximum likelihood estimates of mean-vector and dispersion matrix, testing of hypothesis on mean vectors of multivariate normal populations, cluster analysis, discriminant function, canonical correlation, principal component analysis, factor analysis, multivariate analysis of variance and covariance, multidimensional scaling.

**Stat.-572 Regression Analysis** **1+1** **Sem. I**

**Unit I** Simple and Multiple linear regressions: Least squares fit, Properties andexamples. Polynomial regression: Use of orthogonal polynomials.

**Unit II** Assumptions of regression; diagnostics and transformations; residual analysis ~ Studentized residuals, applications of residuals in detecting outliers, identification of influential observations. Lack of fit, Pure error. Test of normality, test of linearity, Testing homoscedasticity and normality of errors, Durbin-Watson test. Test of goodness of fit for the model evaluation and validation. Concept of multi-collinearity

**Unit III** Weighted least squares method: Properties, and examples. Box-Cox family of transformations. Use of dummy variables, Over fitting and under fitting of model, Selection of variables: Forward selection, Backward elimination. Stepwise and Stagewise regressions.

**Unit IV** Introduction to non-linear models, nonlinear estimation: Least squares fornonlinear models.

**Practical :** Multiple regression fitting with three and four independent variables, estimation of residuals, their applications in outlier detection, distribution of residuals, test of homoscedasticity, and normality, box-cox transformation, restricted estimation of parameters in the model, hypothesis testing, step wise regression analysis; least median of squares norm, orthogonal polynomial fitting.

**Stat.-573 Statistical Computing** **1+1** **Sem. I**

**Unit I** Introduction to statistical packages and computing: data types and structures, Use of Software packages like, SAS, SPSS or "R: The R Projectfor Statistical Computing". Data analysis principles and practice, Summarization and tabulation of data, Exploratory data analysis; Graphical representation of data. Statistical Distributions: Fitting and testing the goodness of fit of discrete and continuous probabilitydistributions;

**Unit II** ANOVA, regression and categorical data methods; model formulation, fitting, diagnostics and validation; Matrix computations in linear models. Analysis of discrete data. Multiple comparisons, Contrast analysis.

**Unit III** Numerical linear algebra, numerical optimization, graphical techniques, numerical approximations, Time Series Analysis.

**Unit IV** Analysis of mixed models; Estimation of variance components, Analysisof Covariance, Fitting of non-linear model, Discriminant function; Principal component analysis. techniques in the analysis of survival data and longitudinal studies, Approaches to handling missing data, and meta- analysis.

**Practical :** Data management, graphical representation of data, descriptive statistics, general linear models ~ fitting and analysis of residuals, outlier detection, fitting and testing the goodness of fit of probability distributions, testing the hypothesis for one sample *t*-test, two sample *t*- test, paired *t*-test, test for large samples - Chi-squares test, f test, one way analysis of variance, contrast and its testing, pairwise comparisons; mixed effect models, estimation of variance components, categorical data analysis, dissimilarity measures, similarity measures, analysis of discrete data, analysis of binary data, numerical algorithms, spatial modeling, cohort studies, clinical trials, analysis of survival data, handling missing data, analysis of time series data - fitting of arima models.

**Stat.-574 Time Series Analysis** **1+1** **Sem. I**

**Unit I** Components of a time-series. Autocorrelation and Partial autocorrelation functions, Correlogram and periodogram analysis.

**Unit II** Linear stationary models: Autoregressive, moving average and Mixed processes. Linear non-stationary models: Autoregressive integrated moving average processes.

**Unit III** Forecasting: Minimum mean square forecasts and their properties, Calculating and updating forecasts.

**Unit IV** Model identification: Objectives, Techniques, and Initial estimates. Model estimation: Likelihood function, Sum of squares function, Least squares estimates. Seasonal models. Intervention analysis models and Outlier detection.

**Practical :** Time series analysis, autocorrelations, correlogram and periodogram, linear stationary model, linear non-stationary model, model identification and model estimation intervention analysis and outlier detection

**Stat.-575 Demography** **2+0** **Sem. I**

**Unit I** Introduction to vital statistics, crude and standard mortality and morbidityrates, Estimation of mortality, Measures of fertility and mortality, period and cohortmeasures.

**Unit II** Life tables and their applications, methods of construction of abridged lifetables, Increment-Decrement Life Tables.

**Unit III** Stationary and stable populations, Migration and immigration. Application of stable population theory to estimate vital rates, migration and its estimation. Demographic relations in non stable populations. Measurement of population growth, Lotka's model (deterministic) and intrinsic rate of growth, Measures of mortality and morbidity period.

**Unit IV** Principle of biological assays, parallel line and slope ratio assays, choice of doses and efficiency in assays quantal responses, probit and logit transformations, epidemiological models.

**Stat.-576 Statistical Methods For Life Sciences** **2+0** **Sem. I**

**Unit I** Proportions and counts, contingency tables, logistic regression models, Poisson regression and log-linear models, models for polytomous data and generalized linear models.

**Unit II** Computing techniques, numerical methods, simulation and general implementation of biostatistical analysis techniques with emphasis on data applications. Analysis of survival time data using parametric and non- parametric models, hypothesis testing, and methods for analyzing censored (partially observed) data with covariates. Topics include marginal estimation of a survival function, estimation of a generalized multivariate linear regression model (allowing missing covariates and/or outcomes).

**Unit III** Proportional Hazard model: Methods of estimation, estimation of survival functions, time-dependent covariates, estimation of a multiplicativeintensity model (such as Cox proportional hazards model) and estimationof causal parameters assuming marginal structural models.

**Unit IV** General theory for developing locally efficient estimators of the parameters of interest in censored data models. Rank tests with censored data. Computing techniques, numerical methods, simulation and general implementation of bio-statistical analysis techniques with emphasis on data applications.

**Unit V** Newton, scoring, and EM algorithms for maximization; smoothing methods; bootstrapping; trees and neural networks; clustering; isotonicregression; Markov chain Monte Carlo methods.

**Stat.-591 Seminar** **1+0**

**Stat.-599 Master's Research** **0+30**

## C) PHYSICS

## Undergraduate Courses

**Phys. 91 Mechanics** **3+1** **Sem. I**

Physical World and Measurement: Physics - scope and excitement, nature of physical laws, physics, technology and society. Need for measurement: units of measurement, systems of units, SI units, fundamental and derived units, Length, mass and time measurements, accuracy and precision of measuring instruments, errors in measurement, significant figures, dimensions of physical quantities, dimensional analysis and its applications. Kinematics: frame of reference, motion in a straight line, position-time graph, speed and velocity, uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity-time, position-time graphs, relations for uniformly accelerated motion (graphical treatment), elementary concepts of differentiation and integration for describing motion, Scalar and vector quantities: position and displacement vectors, general vectors and notation, equality of vectors, multiplication of vectors by a real number, addition and subtraction of vectors, relative velocity. Unit vector: resolution of a vector in a plane - rectangular components, scalar and vector product of vectors, motion in a plane, cases of uniform velocity and uniform acceleration projectile motion, uniform circular motion. Laws of Motion: intuitive concept of force, inertia, Newton's first law of motion; momentum and Newton's second law of motion, impulse, Newton's third law of motion, law of conservation of linear momentum and its applications, equilibrium of concurrent forces, static and kinetic friction, laws of friction, rolling friction, lubrication, dynamics of uniform circular motion, centripetal force, examples of circular motion(vehicle on level circular road, Vehicle on banked road).Work, Energy and Power: work done by a constant force and a variable force; kinetic energy, work-energy theorem, power, notion of potential energy, potential energy of a spring, conservative forces: conservation of mechanical energy (kinetic and potential energies); non- conservative forces, motion in vertical circle; elastic and inelastic collisions in one and two dimensions. Motion of System of Particles and Rigid Body**:** centre of mass of a two-particle system, momentum conversation and centre of mass motion, centre of mass of a rigid body; centre of mass of uniform rod, moment of a force, torque, angular momentum, conservation of angular momentum with some examples; equilibrium of rigid bodies, rigid body rotation and equations of rotational motion, comparison of linear and rotational motions; moment of inertia, radius of gyration; values of moments of inertia for simple geometrical objects (no derivation); statement of parallel and perpendicular axes theorems and their applications.

**Practicals :** Use of vernier-caliper for volume of different shapes, screw-gauge, volume of irregular lamina, spherometer, parallelogram law of vectors, acceleration due to gravity, moment of inertia, co-efficient of friction, compound pendulum, Ketler's pendulum.

**Phys. 92 Matter and Thermodynamics** **3+1** **Sem. II**

Gravitation**:** Keplar's laws of planetary motion, the universal law of gravitation, acceleration due to gravity and its variation with altitude and depth, gravitational potential energy, gravitational potential; escape velocity, orbital velocity of a satellite, geo-stationary satellites. Properties of Bulk Matter: elastic behaviour, stress-strain relationship, Hooke's law, Young's modulus, bulk modulus, shear, modulus of rigidity, poisson's-ratio, elastic energy, pressure due to a fluid column, Pascal's law and its applications (hydraulic lift and hydraulic brakes), effect of gravity on fluid pressure, viscosity, Stokes' law, terminal velocity, Reynold's number, streamline and turbulent flow, critical velocity; Bernoulli's theorem and its

applications, surface energy and surface tension, angle of contact, excess of pressure, application of surface tension ideas to drops, bubbles and capillary rise; heat, temperature, thermal expansion; thermal expansion of solids, liquids and gases, anomalous expansion, specific heat capacity: Cp, Cv- calorimetry, change of state-latent heat, heat transfer-conduction, convection radiation and thermal conductivity, qualitative idea of blackbody radiation, Newton's law of cooling and Stefan's law, Wein's displacement law, greenhouse effect. Thermodynamics: thermal equilibrium and definition of temperature (zeroth law of thermodynamics); heat, work and internal energy; first law of thermodynamics, isothermal and adiabatic processes; second law of thermodynamics, reversible and irreversible processes; heat engines and refrigerators. Behaviour of Perfect Gas and Kinetic theory: **e**quation of state of a perfect gas, work done on compressing a gas; kinetic theory of gases, assumptions, concept of pressure. Kinetic energy and temperature; rms, speed of gas molecules; degrees of freedom, law of equipartition of energy (statement only) and application to specific heat capacities of gases, concept of mean free path, Avogadro's number. Oscillations and Waves: periodic motion, period, frequency, displacement as a function of time, periodic functions; simple harmonic motion (S.H.M) and its equation, phase, oscillations of a spring-restoring force and force constant; energy in S.H.M.- kinetic and potential energies; simple pendulum-derivation of expression for its time period; free, forced and damped oscillations (qualitative ideas only), resonance; wave motion; longitudinal and transverse waves, speed of wave motion, displacement-relation for a progressive wave, principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics, Beats, Doppler effect.

**Practicals :** Gravitational pull of the earth, beam balance, Hook's law, resonance, sonometer, specific heat of the sand, coefficient of viscosity, Newton's law of cooling, surface tension, latent heat, Young's modulus.

**Phys. 93 Electricity and Magnetism** **3+1** **Sem. I**

Electrostatics: electric charges and their conservation, Coulomb's law-force between two point charges, forces between multiple charges; superposition principle and continuous charge distribution; electrical field, electric field due to a point charge, electric-field lines; electric dipole, electric field due to a dipole; torque on a dipole in uniform electric field; electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (Field inside and outside); electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges, equipotential surfaces, electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field. Conductors and Insulators: free charges and bound charges inside a conductor; dielectrics and electric polarisation, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor, Van de Graaf generator. Current Electricity: electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current; Ohm's law, electrical resistance, V-1 characteristics (linear and non linear), electrical energy and power, electrical resistivity and conductivity; carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistance; internal resistance of a cell, potential difference and emf of cell, combination of cells in series and in parallel; Kirchhoff's laws and simple applications, Wheatstone bridge, meter bridge, potentiometer-principle and its applications to measure potential difference and for comparing emf of two cells, measurement of internal resistance of a cell. Magnetic Effects of Current and Magnetism: concept of magnetic field, Oersted's experiment, Biot-savart law and its application to current carrying circular loop; Ampere's law and its applications to infinitely long straight wire, straight and toroidal solenoids; Force on a moving charge in uniform magnetic and electric fields, cyclotron; force on a current-carrying conductor in a uniform magnetic field, force between two parallel current-carrying conductors, definition of ampere, torque experienced by a current loop in uniform magnetic field, moving coil galvanometers- its current sensitivity and conversion to ammeter and voltmeter, current loop as a magnetic dipole and its magnetic dipole moment, magnetic dipole moment of a revolving electron, magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis, torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; earth's magnetic field and magnetic elements, para-,dia-and ferro-magnetic substances with examples, electromagnets and factors affecting their strengths, permanent magnets. Electromagnetic Induction and

Alternating Currents: electromagnetic induction, Faraday's laws, induced emf and current, Lenz's Law, Eddy currents: Self and mutual inductance; alternating current, peak and rms value of alternating current/ voltage; reactance and impedances; LC oscillations, (qualitative treat ment only), LCR series circuit resonance, power in AC circuit, wattless current, AC generator and transformer. Electromagnetic Waves: need for displacement current, electromagnetic waves and their characteristics (qualitative ideas only), transverse nature of electromagnetic waves, electromagnetic spectrum (radio waves, radio-microwaves, infra-red, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.

**Practicals** : Specific resistance of material using meter bridge, laws of combination (series/parallel) of resistance using meter bridge, compare the emf of two given primary cells, internal resistance of given primary cell, resistance of a galvanometer, frequency of the A.C. mains with a sonometer, Ohm's law and to measure the unknown resistance, laws of combination (series/parallel) of resistance using Ohm's law, magnetic line of forces, comparison of magnetic moment by tanA and tanB method.

**Phys. 94 Optics, Nuclear Physics and Electronics** **3+1** **Sem. II**

Optics: reflection of light, spherical mirrors, mirror formula, refraction of light, total internal reflection and its applications, optical fibres, refraction at spherical surfaces, lenses, thin lens formula, lens-maker's formula; magnification, power of a lens, combination of thin lenses in contact, combination of lens and mirror, refraction and dispersion of light through a prism, scattering of light-blue colour of the sky and reddish appearance of the sun at sunrise and sunset. Optical Instruments: human eye, image formation and accommodation, correction of eye defects (myopia, hypermetropia) using lenses; microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers. Waves Optics: wave front and Huygens' Principle, reflection and refraction of plane wave at a plane surface using wave fronts; proof of laws of reflection and refraction using Huygens 'Principle. Interference: Young's double hole experiment and expression for fringe width, coherent sources and sustained interference of light, diffraction due to a single slit, width of central maximum; resolving power of microscopes and astronomical telescopes; polarisation, plane polarised light- Brewster's law, uses of plane polarised light and Polaroids. Dual Nature of Matter and Radiation: photoelectric effect, Hertz and Lenard's observations'; Einstein's photoelectric equation, particle nature of light, matter waves-wave nature of particles, de Broglie relation, Davission-Germer experiment (experimental details should be omitted; only conclusion should be explained).Atoms and Nuclei: alpha-particle scattering experiment, Rutherford's model of atom, Bohr model, energy levels, hydrogen spectrum, composition and size of nucleus, atomic masses, isotopes, isobars, isotones, radioactivity- alpha, beta and gamma particles/rays and their properties, radioactive decay law, mass-energy relation, mass-defect, binding energy per nucleon and its variation with mass number, nuclear fission and fusion. Electronic Devices: energy bands in solids (qualitative idea only) conductor, insulators and semiconductors; semiconductor Diode-I-V characteristics in forward and reverse bias, diode as a rectifier, I-V characteristics of LED, photodiode, solar cell and Zener diode, Zener diode as a voltage regulator, junction transistor, transistor action. Characteristics of a transistor: transistor as an amplifier (common emitter configuration) and oscillator, logic gates (OR, AND, NOT, NAND and NOR), transistor as a switch. Communication Systems: elements of a communication system (block diagram only), bandwidth of signals (speech, TV and digital data), bandwidth of transmission medium, propagation of electromagnetic waves in the atmosphere, sky and space wave propagation, need for modulation, production and detection of an amplitude modulated wave.

**Practicals :** Concave mirror and find their focal length, lens-maker formula, focal length of a convex mirror using a convex lens, focal length of a concave lens using a convex lens, angle of minimum deviation for a given prism, I-V characteristic curve of a p-n junction, Zener diode characteristic, characteristics of a common-emitter npn or pnp transistor, reflective index of a glass slab using a traveling microscope, refractive index of a liquid by using concave mirror and convex lens.

**Phys. 102 Optics** **3+1** **Sem. II**

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Division of amplitude and wavefront. Spatial and temporal coherence, Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Newton's rings, Michelson interferometer—working, principle and nature of fringes. Interference in thin films, Role of interference in anti-reflection. Multiple beam interference, Fabry-Perot interferometer, nature of fringes. Fresnel's Assumptions. Fresnel's Half-

Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Concept and analytical treatment of unpolarized, plane polarized and elliptically polarized light. Double refraction, Nicol prism, sheet polarisers, retardation plates. Production and analysis of polarized light (quarter and half wave plates). Polarization by reflection, Malus law, Brewster's angle.

**Practicals :** Refractive index and dispersive power of the prism using spectrometer. Calibration of prism spectrometer. Newton's rings. Polarimeter. Diffraction grating. Resolving power of telescope and grating. Ostwald viscometer. Planck's constant using photovoltaic cell.

**Phys. 103 Mechanics** **3+1** **Sem. I**

Cartesian and spherical polar co-ordinate systems: area, volume, displacement, velocity and acceleration in these systems, solid angles; Centre of mass system, principle of conservation of momentum about the Centre of mass, Conservation of Energy; Galilean transformation, Galilean Invariance of space & time intervals; Symmetries of space and time; Rigid body motion, Euler's equation, elementary gyroscope. Fictitious forces. Effect of rotation of earth on 'g'. Effects of centrifugal and Coriolis forces produced as a result of earth's rotation. Foucault's pendulum and its equation of motion. Michelson-Morley Experiment and its outcome. Forces in nature (qualitative). Central forces, Potential energy and force between a point mass and spherical shell, a point mass and solid sphere, gravitational and electrostatic self-energy. Two body problem and concept of reduced mass. Motion of a body under central force; differential equation of the orbit, equation of orbit in inverse-square force field. Kepler's laws and their derivation, Shape of Galaxy. Elastic collisions in laboratory and center of mass systems; velocities, angles, energies in these systems and their relationships. Rutherford scattering.

**Practicals :** Use of vernier-caliper for volume of different shapes, screw-gauge, volume of irregular lamina, spherometer, acceleration due to gravity, moment of inertia, co-efficient of friction, compound pendulum, Ketler's pendulum, elastic Constants of a wire by Searle's method, Moment of Inertia of a Flywheel, Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity, Coefficient of Viscosity of water by Capillary Flow Method, coefficient of viscosity of a given liquid by Stoke's method, one dimensional collision using two hanging spheres of different materials. Melde's experiment

**Phys. 104 Waves and Oscillations** **3+0** **Sem. II**

Simple harmonic motion, energy of a SHM, Compound Pendulum, Torsional Pendulum, Electrical Oscillations, Transverse Vibrations of a mass on a string, composition of two perpendicular SHM of same period and of period in ratio 1: 2. Decay of free vibrations due to damping, differential equation of motion, types of damping, determination of damping co-efficient; Logarithmic decrement, relaxation time and Q- Factor. Differential equation for forced mechanical and electrical oscillators, Transient and steady state behavior. Displacement and velocity variation with driving force frequency, variation of phase with frequency, resonance. Power supplied to an oscillator and its variation with frequency. Q-value and band width. Q-value as an amplification factor. Stiffness, coupled oscillators, Normal co-ordinates and normal modes of vibration, Inductance coupling of electrical oscillators. Waves in physical media, Wave equation and its solution, Types of waves, particle velocity, acceleration and energy in progressive waves. Longitudinal waves on a rod. Transverse waves on a string, characteristic impedance of a string, Waves in absorbing media. Reflection and Transmission of transverse waves on a string at discontinuity, Reflection and transmission of energy. Reflection and transmission of longitudinal waves at a boundary. Standing wave ratio, Impedance matching, Energy of vibrating string. Wave and group velocity.

**Phys. 202 Fundamentals of Biophysics** **2+1** **Sem. II**

Quantum mechanics- electronic structure of atoms, wave particle duality, wave length of de-Broglie waves, phase and group velocity. Some basic concepts of quantum mechanics. Schrodinger's wave equations. Particle in a box. Quantum mechanical tunneling. Ist and IInd law of thermodynamics. Enthalpy. Entropy-statistical and thermodynamic definition of entropy. Helmholtz free energy. Equilibrium thermodynamic. Near-equilibrium thermodynamic. Gibbs free energy, chemical potential. Thermodynamic analysis of membrane transport. Hydration of macromolecules- role of friction, diffusion, sedimentation. The

ultracentrifuge. Viscosity. Rotational diffusion. Light scattering. Small angle x-ray scattering. Ultraviolet and visible spectroscopy. Circular dichroism (CD) and optical rotatory dispersion (ORD), fluorescence spectroscopy, infrared spectroscopy, Raman spectroscopy, electron spin resonance and NMR spectroscopy. Light microscopy. Electron optics- transmission electron microscope (TEM), scanning electron microscope (SEM). Preparation of the specimen for electron microscopy. Image reconstruction. Electron diffraction. Tunnelling electron microscope. Atomic force microscope. Crystals and symmetries, crystal systems, point group and space groups. Growth of crystals of biological molecules. X-ray diffraction.

**Practicals :** Refractive index and dispersive power of the prism using spectrometer. Calibration of prism spectrometer. Newton's rings. Polarimeter. Diffraction grating. Resolving power of telescope and grating. Ostwald viscometer. Planck's constant using photovoltaic cell. Photo spectrometer. Photoelectric effect. Stefan's constant. Thermal diffusivity in metals.

**Phys. 203 Engineering Physics** **2+1** **Sem. I**

Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization. Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Wave particle quality, de-Broglie concept, uncertainty principle. Wave function. Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function. Bands in solids, velocity of Bloch's electron and effective mass. Distinction between metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, law of mass action. Determination of energy gap in semiconductors. Donors and acceptor levels. Superconductivity, critical magnetic field. Meissner effect. Isotope effect. Type-I and II superconductors, Josephson's effect DC and AC, Squids. Introduction to high $T_c$ superconductors. Spontaneous and stimulated emission, Einstein A and B coefficients. Population inversion, He-Ne and Ruby lasers. Ammonia and Ruby masers. Holography-Note. Optical fiber. Physical structure. basic theory. Mode type, input output characteristics of optical fiber and applications. Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.

**Practicals :** To find the frequency of A.C. supply using an electrical vibrator; To find the low resistance using Carey Foster bridge without calibrating the bridge wire; To determine dielectric constant of material using De Sauty's bridge; To determine the value of specific charge (e/m) for electrons by helical method; To study the induced e.m.f. as a function of velocity of the magnet; To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil; To determine the energy band gap in a semiconductor using a p-n Junction diode; To determine the slit width from Fraunhofer diffraction pattern using laser beam; To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link; To study the phase relationships in L.R. circuit; To study LCR circuit; To study the variations of thermo emf of a copper-constantan thermo-couple with temperature; To find the wave length of light by prism.

## POSTGRADUATE COURSES

**Phys.-501 Classical and Statistical Mechanics** **4+0** **Sem. I**

**Unit I** Mechanics of a system of particles, constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity-dependent forces and the dissipation function, Lagrange's equations of motion, Calculation of variations, Hamilton's Principle and Euler-Lagrange's differential equations of motion, Advantages of variational principle formulation, Conservation theorems and symmetry properties. Legendre Transformation, Hamilton's equations of motion, Cyclic-co-ordinates, Hamilton's equations from variational principle, Principle of least action.

**Unit II** Hamilton's equations of motion, Canonical transformation, Poisson's brackets and its relations, Infinitesimal contact transformation, Hamilton Jacobi equations for principal and characteristic functions, Harmonic oscillator problem, Action angle variables. First integrals, Equivalent one-dimensional problem and classification of orbits, differential equation for the orbit, Kepler's problem, Scattering in a central force field, Euler angles, Coriolis force.

Independent co-ordinates of rigid body, orthogonal transformations, Motion of a rigid body, Euler angles and Euler's theorem, Rate of change of a vector, infinitesimal rotation, Inertia tensor and principal axis transformation.

**Unit III** Macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution. Elements of ensemble theory: phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles, equipartition and virial theorems. Canonical ensemble: Equilibrium between a system and a heat reservoir, a system in the canonical ensemble and, physical significance of various statistical quantities, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, a system of harmonic oscillators as canonical ensemble, statistics of paramagnetism, thermodynamics of magnetic systems and negative temperatures.

**Unit IV** The grand canonical ensemble: Equilibrium between a system and a particle-energy reservoir and significance of statistical quantities. Classical ideal gas in grand canonical ensemble theory. Density and energy fluctuations. Elements of Quantum Statistics: Quantum states and phase space, quantum statistics of various ensembles. An ideal gas in quantum mechanical ensembles, statistics of occupation numbers. Basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, Ideal Fermi Systems: thermodynamic behaviour of an ideal fermi gas, discussion of heat capacity of a free-electron gas at low temperatures.

**Phys.-502 Electronics** **2+1** **Sem. I**

**Unit I** High pass RC circuits: response to step, pulse, square and exponential wave forms, application as differentiator. Low pass RC circuit: response to step, pulse, square and exponential waveforms, application as integrator. Multivibrators: bistable, monostable and astable: operation and triggering and frequency of oscillation. Diode as clipper, series clippers, transistor clippers

**Unit II** Concept of DC positive logic, negative logic systems, Boolean algebra, logic gates, de Morgans theorem, Data processing circuits: Multiplexers, Demultiplexers, Encoders, Decoders, Parity generators. Half-adder, full-adder, subtractor, flip flops: SR, JK and Master Slave JK, D type and T-type. Shift registers, counters and their types and applications.

**Unit III** Analogue to digital converters, digital to analogue converter, digital display, seven segment display. Operational amplifiers: emitter coupled differential amplifier, characteristics, common mode rejection ratio. Basics operational amplifier applications: scale, adder, summer etc. Non-linear analog system: logarithmic, anti-log amplifier, multiplier and integrator.

**Unit IV** Microprocessor: Fundamentals of microprocessors, buffer registers, bus organized computers, SAP-I, Microprocessor (μP) 8085 architecture, memory interfacing, interfacing I/O devices. SAP-2 and SAP-3: architecture, instructions, programming in assembly language. Generation and detection of SSB waves.

**Practical :** Verification of all logic gates, verification of half adder and full adder, subtractor. To determine the frequency of astable multivibrator, analogue to digital conversion (a/d) digital to analogue conversion (d/a), k/e ratio measurement, To measure voltage, gain of op-amps (741), To study zener diode characteristics, band filters, signal shaper, design and study of various flip flops circuits (rs, d, jk, t) , design and study of various counter circuits (up, down, ring, mod-n)

**Phys.-503 Quantum mechanics** **3+0** **Sem. II**

**Unit I** Basic concepts and quantum kinematics: Dirac's bra and ket notations; Linear vector space; inner product; operators and properties of operators; Eigenkets of an observable; eigenkets as basekets, Matrix representations; Change of basis; unitary transformation; Postulates of quantum mechanics; Matrix approach to quantum mechanics; Quantum dynamics.

**Unit II** Theory of angular momentum: Schrodinger equation for spherically symmetric potential, orbital angular momentum operator, Eigen values and eigen vectors of $L^2$ and $L_z$.Rotations and angular momentum commutation relations. Spin angular momentum. Eigenvalues and eigenvectors of $J^2$ and $J_z$. Pauli spin matrices and spin wave functions, raising and lowering operators, matrix formulation of general angular momenta. Addition of angular momenta, C.G. coefficients.

**Unit III** Approximation methods: Non-degenerate and degenerate time independent perturbation theories with application to Stark effect. Variational method with application to ground states of harmonic oscillator, hydrogen atom and other simple cases. First order time dependent perturbation theory, constant and harmonic perturbations. Fermi's golden rule and its application to radiative transitions in atoms. WKB approximation.

**Unit IV** Scattering theory: Scattering cross-section and scattering amplitude, partial wave analysis. Green's function in scattering. Born approximation and its application to square well potential and screened coulomb potential. Optical theorem, Scattering of identical particles: symmetric and anti-symmetric wave functions. Heitler-London theory of hydrogen molecule, helium atom.

**Unit V** Relativistic quantum mechanics: Klein Gordon equation, Dirac equation and its plane wave solution, significance of negative energy states. Existence of spin angular momentum of Dirac particles. Electron in electromagnetic fields. Dirac equation for a particle in central field.

**Phys.-504 Electrodynamics** **3+0** **Sem. I**

**Unit I** Electrostatics and Magnetostatics: Gauss's law and its applications, Laplace and Poisson's equations, Electrostatic potential energy. The differential equations of magnetostatics, Vector potential, Magnetic field of a localized current distribution, Force and torque on a localized current distribution. Electrostatics of Dielectrics: Static fields in material media. Polarization vector, macroscopic equations. Molecular polarizability and electric susceptibility. Clasusius-Mossetti relation. Models of Molecular Polarizability. Energy of charges in dielectric media. Multipole expansion of the scalar potential of a charge distribution. Dipole moment, quadrupole moment. Multipole expansion of the energy of a charge distribution in an external field.

**Unit II** Boundary value problems: Uniqueness Theorem. Dirichlet of Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic Boundary value problem with Green function. Method of images with examples. Magnetostatics Boundary value problems. Time varying fields and Maxwell equations: Faraday's Law of induction. displacement current. Maxwell equations. Scalar and vector potentials. Gauge transformation, Lorentz and Coulomb gauges,General Expression for the electromagnetic field energy, conservation of energy, Poynting's Theorem. Conservation of momentum.

**Unit III** Electromagnetic Waves: Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting's theorem for a complex vector field, waves in conducting media. skin depth. E.M. waves in rare field plasma and their propagation in ionosphere. Reflection and Refraction of EM waves at plane interface, Frensel's amplitude relations. Reflection and transmission coefficients. Polarization by reflection. Brewster's angle, Total internal reflection. EM wave guides. TE and TM waves, Rectangular wave guides. Energy flow and attenuation in wave guides. Cavity resonator.

**Unit IV** Radiation from Localized Time Varying Sources: Solutions of the inhomogeneous wave equation in the absence of boundaries. Fields and Radiation of a localized oscillating source. Electric dipole and electric quadrupole fields, centre fed linear antenna. Radiation From Accelerated Charges: Lienard-Wiechert Potentials, Field of a charge in arbitrary motion and uniform motion, Radiated power from an accelerated charge at low velocities-Larmor-Power formula. Radiation from a charged particle with collinear velocity and acceleration. Radiation from a charged particle in a circular orbit, Radiation from an ultra- relativistic particle, Bremsstrahlung and Cerenkov radiation. Radiation reaction. Line-width and level shift of an oscillator.

**Unit V** Special Theory of Relativity: Lorentz transformation as orthogonal transformation in 4-dimension, relativistic equation of motion, applications of energy momentum conservation, Disintegration of a particle, C.M. System and reaction thresholds. Covariant Formulation of Electrodynamics in Vacuum: Four vectors in Electrodynamics, 4-current density, 4-potential, covariant continuity equation, wave equation, covariance of Maxwell equations. Electromagnetic field tensor, transformation of EM fields. Invariants of the EM fields. Energy momentum tensor of the EM fields and the conservation laws.

**Phys.-505 Solid State Physics** **3+1 Sem. II**

**Unit I** Reciprocal lattice, Phonon momentum, inelastic scattering by phonons, phonon heat capacity, density of states, Einstein and Debye's model, anharmonic crystal interactions, Thermal conductivity, Thermal resistivity, Umklapp process.

**Unit II** One-electron approximation, Bloch theorem, Kronig-Penney model, Nearly free electron theory, zone schemes, Tight binding theory, construction of fermi surfaces, calculations of energy bands, De Haas-van-Alphen effect, Cyclotron resonance, Magnetoresistance.

**Unit III** Quantum theories of dia, para and ferromagnetism, Weiss molecular field theory of ferromagnetism, Ferrimagnetism and antiferromagnetism, Heisenberg exchange model. Spin waves and magnons.

**Unit IV** Superconductivity: experimental survey, basic phenomenology, BCS pairing mechanism and nature of BCS ground state, Flux quantization, Vortex state of a Type II superconductors, Josephson effect, Tunnelling experiments, High Tc superconductors.

**Unit V** Many electron crystal Hamiltonian, Hall effect, Hartree-Fock approximation, Debye-Waller Factor, Electrostatic screening (Thomas-Fermi and random phase approximations), Quantum Hall effect.

**Practical :** Susceptibility of liquids and solids, hysteresis loss of materials, electron spin resonance**,** four probe methods, Hall effect measurements, dispersion relations with lattice dynamics kit**,** measurement of dielectric constant, microwave experiment, curie temperature of ferrimagnetics, To measure cut-off frequency of monoatomic lattice**,** study the phenomena of magnetoresistance, measurement of velocity of ultrasonic sound waves through given liquid media and calculation of its adiabatic compressibility.

**Phys.-506 Nuclear and Particle Physics** **3+1 Sem. II**

**Unit I** Nuclear mass, size determination, angular momentum, spin, parity, iso-spin and moments of nuclei, binding energy, nuclear magneton. Deuteron binding energy, dipole and quadrupole moments of the deuteron, central and tensor forces. Evidence for saturation property of nuclear force, Neutron-proton scattering, exchange character, spin dependence (ortho and para-hydrogen), charge independence and charge symmetry. Proton- proton scattering (qualitative idea only). Magic numbers, nuclear shell model and applications, collective model.

**Unit II** Nuclear cross-section, interaction of heavy charged particles, light charge particles and gamma rays, interaction of neutrons. Basics statistics and treatment of experimental data. Detector response, energy resolution, efficiency, dead time. Gaseous ionization detectors, drift and mobility, choice of fill gas, multiwire proportional chamber, the drift chamber, properties of drift gases.

**Unit III** Scintillation detectors: general characteristics, organic scintillators, inorganic scintillators, temperature dependence. Particle classification, Yukawa theory, fundamental forces, parity, charge conjugation and time reversal. Spin and parity determination of pions and strange particles, isospin in pion-nucleon system, Gell-Mann Nishijimascheme,Daltiz Plot. Quarks model, Gelmann Okubo formula, w-Φ mixing.

**Unit IV** Symmetries, elementary ideas of SU(2) and SU(3) symmetry groups and hadron classification. Fermi theory of beta decay,Cabibbo mixing, CP violation, CPT theorem, introduction to the standard model. Klein-Gordan equation, concept of particle and anti-particle, Dirac equation, V-A theory of weak interactions, Higgs mechanism.

**Practical :** To measure energy resolution using Gamma ray spectroscop**, v**erification of ynverse square law, To determine operating voltage of GM counter**,** To measure attenuation coefficient using aluminium plates of varying thickness, To determine dead time and efficiency of GM counter using beta radiation**,** To measure half-life of beta sources**,** Counting of statistics, end-point energy of beta sources**,** To check randomcity of GM counter, To measure cross-section for p-p interactions in bubble chamber, To measure cross-section K+-d interaction in bubble chamber.

**Phys.-507 Nuclear Techniques in Agriculture** **2+1** **Sem. II**

**Unit I** Natural, artificial and induced radioactivity, units of radioactivity, interactions of nuclear radiations with matter

**Unit II** Detection and measurement of nuclear radiations, GM counter, solid and liquid scintillation Counters, characteristics of alpha, beta and gamma radiations, nuclear technique.

**Unit III** Crop improvement, adaptability of fertilizers by the plants using tracer techniques, interaction of neutrons with matter and biological materials, nuclear techniques for determining moisture content of soils.

**Unit IV** Determination of nitrogen and protein contents of seeds using nuclear technique, seed oil measurement using NMR technique, water dating, application of Mossbauer spectroscopy in agriculture, radiation hormesis, radiation induced phenomena: food irradiation and radiation protection, radioactive waste disposals.

**Practical :** Half-life determination, neutron activation-based experiments, attenuation studies of beta particle in plant leaves, To determine isotope uptake by plants, To study statistical fluctuations in measurement of counts from beta source, To determine the thickness of leaves.

**Phys.-508 Material Science** **2+1** **Sem. I**

**Unit I** Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor, Crystal defects.

**Unit II** Polymers: Basic concepts & definitions, monomer & functionality, oligomer, polymer, repeating unites, degree of polymerization, molecular weight & molecular weight distribution. Classification of polymers thermoplastic/ thermoset, addition/ condensation, natural /synthetic, crystalline/amorphous, step-growth /chain growth, branched/ crosslinked, Classification of polymers based on end-use.

**Unit III** Phase diagrams: the phase rule, single-component single system, and binary phase diagrams. Microstructural changes during cooling. The lever rule. Nucleation and growth. Nucleation kinetics. The glass transition, recovery, recrystallization, and grain growth.

**Unit IV** Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth.

**Practical :** Cooling curve of binary alloys, study and demonstrate the mechanical behaviour of elastomers, electrical conductivity of ionic solids, dielectric constant and dielectric loss measurement of organic liquids, To measure susceptibility of materials, To measure hysteresis loop of selected materials , Four probe methods, Hall effect measurements, dispersion relations with lattice dynamics kit

**Phys.-509 Radiation Physics** **2+1** **Sem. II**

**Unit I** Types of radiations, radioactivity, half-life, radioactive series, alpha decay - quantum mechanical tunnelling (qualitative). Beta decay - continuous beta ray spectrum - neutrino hypothesis. Fermi's theory of beta decay. Detection of neutrino - non-conservation of parity in beta decay. Gamma decay Internal conversion and electron capture (qualitative only).

**Unit II** Interactions of heavy charged particle and electrons with matter - specific energy loss, stopping power, radiative mode of energy loss, electron range and transmission curves, radiation length. Interaction of gamma rays with matter - Elastic scattering, photoelectric effect, Compton scattering, Klein-Nishina formula (qualitative) and pair production processes, cross section, gamma ray attenuation, linear and mass absorption coefficients.

**Unit III** Radiation detectors - Gas filled counters - general features - ionization chamber, proportional counter and GM counter. Van de Graaf accelerator, cyclotron, linac, synchronous accelerator, colliding beams.

**Unit IV** Interaction of neutrons: general properties, energy classification, elastic and inelastic scattering, nuclear reaction, neutron activation and induced activity, radioisotope production, Nuclear fission. Radiation quantities and units - radiation exposure, absorbed dose, equivalent dose and effective dose.

**Practicals :** Half-life determination**,** Verification of inverse square law, attenuation studies of beta particle in plant leaves, To determine isotope uptake by plants, To study statistical fluctuations in measurement of counts from beta source, To measure half-life of beta sources, counting of statistics, end-point energy of beta sources, To check randomcity of GM counter, energy resolution of a scintillation spectrometer

**Phys.-510 Solid State Devices** **2+1** **Sem. I**

**Unit I** Regulated power supplies. CRO. Electronic instruments for measurements of voltage, current resistance and other circuit parameters.

**Unit II** Signal generators. Transducers. pH meter. Conductivity meters, Dipole meter. Basic concepts of operation Astable, Monostable and Bistable multivibrator, quantitative discussion of Quasi stable state and Symmetrical and Unsymmetrical triggering, quantitative discussion of time periods, Applications of Vibrators.

**Unit III** Differentials Amplifier, Transfer Characteristic Frequency Characteristic, IC Operational Amplifier, Compensation in Operational Amplifiers. Application of Op-Amp As adder, Multiplier, Differentiator, Integrator, Logarithmic and Anti-logarithmic Amplifier, Application of Operational Amplifier to Analog Computation.

**Unit IV** IC Fabrication: Standard gate assemblies, Fabrication of integrated Circuits and Devices: Basic ideas of integrated circuits Epitaxial growth, Diffusion, Masking, Etching, Fabrication of Monolithic Integrated circuits.

**Practical :** Study of cro and a multimeter as a measuring device, study of regulated power supply, astable multivibrator, logic gates, half and full adder, flip flops (rs, jk, ms jk, d type), half and full subtractors

**Phys.-511 Agricultural Physics** **2+0** **Sem. II**

**Unit I** Thermal properties of soil constituents. Heat flux in soil Fourier laws.

**Unit II** Movement of heat in the soil. Water flux in soil and plant systems. Movement of water in soil, evaporation, humidity.

**Unit III** Aerodynamics in soil plant system. Physical force fields in soil plant system. Radiation and energy balance of atmosphere and earth surface.

**Unit IV** Remote sensing system. Sensors. Resolution and data analysis. Use of radio isotopes in agriculture.

**Phys.-512 Principles of Remote Sensing and its Applications in Agriculture** **2+0** **Sem. I**

**Unit I** Basic components of remote sensing: signals, sensors and sensing systems. Active and passive remote sensing. Characteristics of electromagnetic radiation and its interaction with matter. Spectral features of earth's surface. remote sensors in visible, infrared and microwave regions. Imaging and non-imaging systems.

**Unit II** Framing and scanning systems. Resolution of sensors. Sensors platforms: their launching and maintenance. Data acquisition system: data processing, storage and dissemination. Digital image processing and information. Information extraction.

**Unit III** Microwave remote sensing. Visual and digital image interpretation. Introduction to GIS and GPS digital techniques for crop stress detection. Soil moisture assessment. Inventory of ground water and satellite measurement of surface soil moisture and temperature.

**Unit IV** Drought monitoring. Monitoring of crop disease and pest infection. Soil resource inventory: land use/land cover mapping and planning and integrated watershed development. Crop yield modelling and crop production forecasting.

**Phys.-513 Principles of Physical Techniques in Agriculture** **2+1** **Sem. I**

**Unit I** Principle of measurements: laboratory, field and regional scales. Principles of optical and polarized microscopes: reflection, transmission and absorption in relation to properties of object. Colorimetric techniques: single and double beam instruments.

**Unit II** Spectrophotometry. Beer and Lambert law. Fluorescence. Raman spectra. Sensors and transducers. Principle of leaf area meter. Canopy analyzer. Quantum sensor. Spectro- radiometer. Laser land leveler. Photosynthetic system analyzer for determination of plant water and photosynthetic parameters.

**Unit III** Principle of infrared thermometry. Emissivity laws. Characteristics of agricultural materials. Principle of X-ray and its applications in clay mineralogy; small angle scattering. Principle and applications of electron microscopes.

**Unit IV** Transmission and scanning electron microscopes. Confocal microscope and its applications. Atomic absorption spectroscopy: principle, detection limits and sensitivity.

**Unit V** Nuclear techniques: detection and measurements of charged particles, radiation monitoring instruments. Radiation hazards evaluation and protection. Tracer methodology: isotopes and their applications in agriculture. Gamma irradiation for genetic variability. NMR, mass spectrometer: principle and applications.

**Practical :** Discharge of electricity through gases, ionization current measurements, photoelectric effect and measurements, Geiger Muller counter-quenching time, thickness measurement of thin films/ foils/ paper sheets, half-life determination, tracer applications of artificial radio nuclides, multi-channel analyser for energy resolution**,** verification of inverse square law

**Phys.-515 Modern Physics** **2+1** **Sem. I**

**Unit I** Blackbody spectra, UV catastrophe, Planck's hypothesis, Compton effect (qualitative only), pair production, DE Broglie waves, phase and group velocity, Quantum theory of hydrogen atom.

**Unit II** Special theory of relativity, time dilation, Doppler effect, length contraction, twin paradox, massless state, relativistic momentum, mass and energy equivalence, four vector and space-time diagram.

**Unit III** Magnetic properties of materials. Orbital and spin magnetic moments of an electron. Bohr magnetron, Classical theory of dia, para and ferromagnetism. Specific heat, heat capacity, Debye and Einstein models for specific heat of solids.

**Unit IV** Optical fibre, light propagation in step and graded index fibre, fibre losses. Optical and laser source, holography and applications.

**Practical :** Determination of magnetic susceptibility, dielectric constant measurement, hysteresis loss measurement of various materials, e/m ratio measurement of electron, michelson interferometer, characteristics of photocell, variation of magnetic field (ghee's method), verification of inverse square law for intensity, photoelectric effect and measurement of planck's constant

**Phys.-516 Atomic and Molecular Spectroscopy** **2+0** **Sem. II**

**Unit I** Vector model of atom, quantum states of an electron in an atom, electron spin, spectrum of helium and alkali atom, relativisticcorrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, spectral terms for equivalent electrons, width of spectral lines, LS & JJ couplings.

**Unit II** Zeeman and Anomalous Zeeman effect, Paschen-Bach &Stark effects. Electromagnetic spectrum, Electron spin resonance. Nuclear magnetic resonance, chemical shift.

**Unit III** Frank-Condon principle. Electronic spectra, rotational and vibrational Raman spectra, selection rules, Mossbauer spectroscopy.

**Phys.-517/Math.-533 Mathematical Physics-I** **3+0** **Sem. I**

**Unit I** Laplace transform, its properties and its applications for the solution of differential equations. Fourier series, Fourier integral and its applications

**Unit II** Series solution technique for the solution of linear ordinary differential equations of variable coefficients, Frobenius Method

**Unit III** Bessel equation, properties of Bessel functions, Legendre equation, Legendre associated functions and their properties. Hermite, Laguerre and respective special functions.

**Unit IV** Complex integrals, Cauchy's integral theorem, Cauchy's integral formula and evaluation of line integral by complex integration**,** Taylor's and Laurant's series.

**Unit V** Integration by methods of residuals, Contour integration. Complex analytic function, potential theory and applications to two-dimensional fluid flow.

**Phys.-518/Math.-534 Mathematical Physics-II** **2+1** **Sem. II**

**Unit I** Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigen values and eigen vectors.

**Unit II** Linear ordinary differential equations of second & higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, Green's function as a solution technique for non-homogeneous ordinary differential equations.

**Unit III** Partial differential equations of first order, variable separable technique for the solution of heat equation, wave equation, Laplace equation.

**Unit IV** Numerical solution of algebraic and transcendental equations by bisection, secant and Newton-Raphson, Difference operators, divided differences, interpolating polynomials using finite differences, Numerical Integration: General formulae, Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods.

**Unit V** Introductory group theory, Transformation of co-ordinates. Indicial and summation conventions, covariant and contravariant vectors, invariant tensors.

**Practical :** Vector algebra and vector calculus, eigen values and eigen vectors, linear ordinary differential equations of second & higher orders, heat equation, wave equation, Laplace equation, solution of first order differential equation, numerical solution of algebraic and transcendental equations, numerical integration, finite difference methods.

**Phys.-591 Seminar** **1+0**

**Phys. 599 Master's Research** **0+30**

# MICROBIOLOGY

## PROGRAMMES

**M.Sc. Microbiology**
**Ph.D. Microbiology**
**Five Year Integrated M.Sc. (Hons.)**

## COURSE REQUIREMENTS

### M.Sc. Microbiology

| | |
|---|---|
| Fields of specialization | Industrial Microbiology, Microbial Genetics, Soil Microbiology, Food Microbiology |
| Core Courses | Micro.-502, Micro.-503, Micro.-505, Micro.-507 |
| Minor fields | Biochemistry, Plant Breeding and Genetics, Soil Science, Plant Pathology, Food Science and Technology, Biotechnology or any other as approved by the Dean, Postgraduate studies |
| Supporting Courses | Stat.-502 and courses from subject matter fields (other than Major and Minor) relating to area of special interest and research problems. |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Deficiency courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Ph.D.

| | |
|---|---|
| Fields of specialization | Industrial Microbiology, Microbial Genetics, Soil Microbiology, Food Microbiology. |
| Core Courses | Micro.-601, Micro.-603 and Micro.-605 |
| Minor fields | Biochemistry, Plant Breeding and Genetics, Soil Science, Plant Pathology, Food Science and Technology, Biotechnology or any other as approved by the Dean, Postgraduate studies |
| Supporting Courses | Courses from subject matter fields (other than Minor) relating to area of special interest and research problems. |
| Deficiency courses | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Five Year Integrated M.Sc. (Hons.)

| | |
|---|---|
| Fields of specialization | Industrial Microbiology, Microbial Genetics, Soil Microbiology, Food Microbiology |
| Core Courses | All courses listed for Semester I-VI and Micro.- 502, Micro.-503, Micro.-505, Micro.-507. |
| Minor fields | Biochemistry, Plant Breeding and Genetics, Soil Science, Plant Pathology, Food Science and Technology, Biotechnology or any other as approved by the Dean, Postgraduate studies. |
| Supporting Courses | Stat.-502 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem |
| Common courses | PGS-501, PGS-502, PGS-503, PGS-504 and PGS-505 |
| Deficiency courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses

**Micro. 102 Elementary Microbiology** **2+1 Sem. I & II**

History of Microbiology and its applied areas. Introduction to prokaryotic and eukaryotic cell. Major groups of prokaryotes – Actinomycetes, Cyanobacteria, Archaebacteria, Rickettsias and Chlamydia. Major groups of eukaryotes- fungi, algae and protozoa. Bacterial growth. Metabolism in bacteria - ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation. Viruses, Bacteriophages - structure and properties, lytic and lysogenic cycles. viriods, prions. Bacterial genetics- Genetic recombination, transformation, conjugation and transduction, plasmids, transposons. Carbon, Nitrogen, Phosphorus and Sulphur cycles. Role of microbial groups in soil fertility and crop production, biofertilizers, biological nitrogen fixation - symbiotic, associative and asymbiotic. *Azolla*, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare- silage production, biopesticides, biofuel / biogas production and biodegradation of agro-waste. Edible and poisonous mushrooms. Cultivation technology of mushrooms. Microbiology of water and food.

**Practical** : Introduction to microbiology laboratory and its equipments. Microscopy, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and preparation. Enumeration of microbial population in soil - bacteria, fungi and actinomycetes. Methods of isolation and purification of *Rhizobium* from legume root nodule, *Azotobacter* from soil, *Azospirillum* from roots and BGA from soil. Staining and microscopic examination of microbes. Micrometry.

**Micro. 103 General Microbiology** **2+1 Sem I**

Evolution and scope of microbiology. History of microbiology. Microbial classification, nomenclature and identification. Taxonomic groups. General methods of classifying bacteria. Microscopy and microscopes: Smears and staining. Morphology and fine structure of bacteria. Cultivation of bacteria, nutritional requirements. Nutritional classification of bacteria; Phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Bacteriological media, Growth of bacteria, Reproduction of bacteria; Introduction to fungi, algae and protozoa and virus, Microbiology of water and food Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport. Metabolism in bacteria –ATP generation Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, mutagenesis; Mutation rate, repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants; Destruction of microorganisms: Physical agents and chemical agents; Chemotherapeutic agents and chemotherapy; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

**Practical** : Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, Gram staining, negative staining, capsule-staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

**Micro. 104 Food Microbiology** **2+1 Sem. II**

Importance and significance of microbes in food science. Microbial spoilage of foods. Factors affecting kinds, numbers, growth and survival of microorganisms in foods. Intrinsic factors- pH, water activity, nutrients etc. Extrinsic factors-relative humidity, temperature, gaseous atmosphere. Chemical changes caused by microorganisms. Contamination of foods. Sources of contamination. Genera of bacteria. Maintenance of anaerobic conditions. Asepsis, removal of microorganisms. Intermediate moisture foods. Microbiology of milk and milk products, meat and meat products, fish and other sea foods, poultry and eggs, fruits and vegetables, cereal and cereal products, sugar and sugar products, salts, spices

and canned foods. Shelf life-Calculation of shelf life, shelf life requirements, deteriorative reactions. Food borne intoxications, infections, toxicity and symptoms. Food borne viruses- Polio, Hepatitis A & E, noroviruses, rota viruses, prion diseases, infections, toxicity and symptoms, types of food involved, chemical properties, environmental conditions.

**Practical** : Microbial examination of bacteria and molds from foods. Isolation, identification and confirmation of microbes in milk and milk products, meat and meat products, fish and other sea foods, poultry and eggs, fruits and vegetables, cereals and cereal products, sugar and sugar products, salts, spices and canned food. Determination of thermal death time. Detection of indicator organisms (Coliform/ Enterococcus) in water by MPN method. Determination and enumeration of food borne pathogens from food samples.

**Micro. 201 Basic Microbial Genetics** **2+1 Sem. I**

Microorganisms as tools for genetic studies. Genetic variability in microorganisms. Genetic analysis of representative groups of bacteria, fungi and viruses. Random and tetrad spore analysis. Recombination and chromosomal mapping. Complementation-intergenic and intragenic. Transfer of genetic material in bacteria- conjugation, transformation and transduction. Bacterial plasmids - structure, life cycle, mode of infection and role in genetic engineering. Genetics of bacteriophage, fine structure of gene, life cycle, mode of infection of T4, lambda and M13. Mutation - types, mutagens, DNA damage and repair. Transposable elements. Lac operon. Concept and application of recombinant DNA technology. Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health.

**Practical :** Conjugation and transformation in bacteria. Spontaneous and auxotrophic mutation. Chemical and UV mutagenesis in fungi and bacteria. Complementation in fungi. Identification of mutants using replica plating technique. Isolation of genomic DNA from *E. coli***.** Isolation, curing and identification of plasmid by electrophoresis / antibiotic plates.

**Micro. 202 Introduction to Microbiology** **3+0 Sem II**

Introduction to Microbiology and its scope. Discovery of microorganisms, Microscopy, Brief description of major groups of eukaryotes and prokaryotes. Biology of viruses. Use of microscope and other laboratory equipments. Methods in microbiology and cultivation of microorganisms. Importance of microorganisms in agriculture, organic matter decomposition, cycles of matter in nature. Biological nitrogen fixation. Role of microorganisms in food, dairy and fermentation industries, biogas and waste water treatment. Microorganisms as food. Single Cell Protein. Microorganisms as pathogens.

**Micro. 203 Basic Bacteriology** **2+0 Sem. I**

Bacterial taxonomy, cell structure and organization of bacterial cell, cell wall, periplasm, outer membranes in Gram-ve bacteria, cell surface extensions, motility, role of pili in adhesion, motility, DNA exchange, capsule, spore, heterocysts, Archaebacteria. Unique structures in Eukaryotes, mitochondria and plastids, economic importance of bacteria.

**Micro. 204 Basic Mycology and Phycology** **3+0 Sem. I**

Isolation, distribution, thallus organization, cell structure, nutrition. Sexual and asexual reproduction, spore types, heterothallism and parasexuality in fungi. Classification of fungi and salient features of different classes. Economic importance of fungi. Mushroom cultivation, SCP. Industrially important fungi - *Aspergillus* sp, *Penicillium* sp, their structure and growth characteristics. Role of fungi in antibiotic and enzyme, Solid State Fermentation. Fungal diseases of plants. Introduction of algae,-general classification, morphology and reproduction, photosynthetic apparatus, nitrogen fixation by Cyanobacteria, economic importance of algae.

**Micro. 205 Basic Virology** **2+0 Sem. II**

General properties and classification of viruses. Structure and replication of viruses. Bacterial; virus-structure of bacteriophage, lytic life cycle and lysogeny. Plant viruses, common plant viral diseases-TMV. Satelite virus, viroid. Animal viruses-Rinder pest, Ranikhet, FMD virus-Herpes, HIV, Hepititis. Viral vaccines, prions.

**Micro. 207 Principles of Food Microbiology** **2+1 Sem. I**

Basic aspects and scope of food microbiology. Intrinsic and extrinsic factors affecting microbial growth in foods. Microbial spoilage of fruits, fruit juices, vegetables, meat, poultry, sea foods, carbonated soft drinks, canned foods and cereals. Chemical changes caused by microorganisms and control of spoilage. Food preservation - physical methods**,** chemical preservatives, natural antimicrobial compounds and biology based preservation system. Control of microorganisms by asepsis, water activity, drying, preservatives, use of low and high temperature, radiation and pressure. Microbial contamination, spoilage and prevention of milk and milk products, fruits and vegetables, meat and meat products, fish and other sea foods, poultry and eggs, cereal and cereal products, sugar and sugar products, salts and spices.

**Practical :** General laboratory practices in microbiology laboratory. Equipment used in food microbiology laboratory. Aseptic and sterilization methods. Preparation of media. Isolation and morphological identification of microorganisms. Isolation of molds from foods. Microbial analysis of vegetable and fruits, meat and meat products, fish and other sea foods, eggs and poultry, milk and milk products, cereal and cereal products, sugar, salts and spices and water.

**Micro. 303 / Biotech. 304 Introduction to Industrial Biotechnology** **2+1 Sem. II**

Microbial products; Acids, organic solvents, vitamins, enzymes and biodegradable plastics. Microbial technology; substrates. Upstream and downstream processing, Biotransformation, Fermentors, BOD and COD treatments and disposal of effluents. Hybridization technology and production of vaccines, Production of plant secondary metabolites through cell and hairy root cultures. Concepts of industrial fermentation-batch and continuous, production of biopharmaceuticals, Immobilization techniques.

**Practical** : Isolation, characterization and maintenance of biotechnologically important micro- organisms. Use of laboratory and industrial scale shaker. Batch and continuous cultures. Use of fermentors. Raising somatic cell cultures. Hairy root cultures.

**Micro. 304 Introduction to Applied Microbiology** **3+0 Sem. I**

Important disciplines of applied microbiology. Importance and applications of microorganisms in food, dairy and industry. Food spoilage and food borne diseases. Food preservation and sanitation. Microbiology of milk and milk products. Industrial fermentation of alcohol, alcoholic beverages and enzymes. Brief account of agriculturally important microorganisms - biofertilizers, biopesticides and bioremediation.

**Micro. 305 Basic Experiments in Microbiology** **0+3 Sem. II**

**Practical :** Microscopy. Examination of different types of bacteria, fungi and other microorganisms, motility. Media preparation, isolation, cultivation and purification of microorganisms from air, soil and water. Principle and working - autoclave, laminar flow bench, hot air oven and other commonly used laboratory equipments. Measure of bacterial cell size, DMC using haemocytometer. Sterilization techniques.

**Micro. 306 Fundamentals of Food and Dairy Microbiology** **3+1 Sem. I**

Introduction and importance of food and dairy microbiology. Food spoilage. Food preservation by physical and chemical means. Microbiology of cereals, meat, poultry, egg, fruits and vegetables, salt, sugar. Fermented foods-bread, malt beverages. Role of microorganisms in fermented milk products - butter and cheese, etc. Microbial enzymes in food processing. Pathogenic bacteria in milk and milk products and processed foods. Food poisoning and its control.

**Practical** : Microbiological examination of various foods-fruits and vegetables, meat, milk and milk products-enumeration. Dye reduction test for assessing quality of milk. Starter culture-preparation, evaluation and application. Microbiological analysis of water.

**Micro. 307 Bacterial Genetics** **3+0 Sem. I**

Bacteria as tool for genetic studies, nature of genetic material, DNA structure, function, replication and synthesis. DNA damage and repair. RNA - types and functions. Mutations and their chemical basis, mutagenesis, spontaneous and induced mutations, reversion and suppression of mutants. Bacterial recombination- transformation, transduction and conjugation. Bacterial plasmids, fertility factors, resistance factors, transposable elements and insertion sequences. Role of genetic engineering in improving bacterial strains.

**Micro. 308 Fundamentals of Industrial Microbiology** **2+1** **Sem. II**

History of industrial microbiology. Primary and secondary metabolites produced by the microorganisms. Screening of microorganisms. Preservation of microorganisms. Organizations involved in microbiological work. Fermentation media, industrial sterilization, thermal death time, media heat sterilization, continuous sterilization, design of sterilization, deterministic and probabilistic approach in designing of sterilizing equipments, sterilization charts. Fermentor - components, parts, peripheral parts and accessories. Types of fermentors. Types of fermentations. Microbial production of industrially important secondary metabolites. Probiotics - role of beneficial organisms in fermented foods. Production of bacteriocins, nisin and microbial enzymes. Downstream processing for extraction; purification; concentration. Product recovery - foaming, filtration, centrifugation, cell disruption methods - mechanical and non-mechanical methods.

**Practical** : Isolation and screening of citric acid/ amylase/ protease /antibiotic and biocolours producing microbes. Production, purification and estimation of citric acid/lactic acid/ acetic acid. Standardization of fermentation conditions for higher yields of citric acid. Production, purification, estimation of beer/ ethanol. Assay of fungal amylases/proteases/Lipase, Assay of Nisin**.** Production of single cell proteins and mushrooms. Starter activity of Baker's yeast.

**Micro. 401 Practicals in Microbiology** **0+2** **Sem. II**

Microscopy-phase contrast, fluorescent and electron microscope. Morphological, physiological and biochemical characterization of microorganisms. Maintenance and preservation of cultures. Growth curve of bacteria and fungi. Measurement of growth, microbial sensitivity. Production of microbial biomass and protein estimation. Replica plating technique. Composting of organic residues. Principles and working of pH meter, Spectrophotometer and electrophoresis.

**Micro. 421 Fundamentals of Microbiology** **2+1** **Sem. II**

History of microbiology. Nature and properties of prokaryotic and eukaryotic microorganisms. Brief discussion on taxonomy of microorganisms. Biology of viruses. Cultivation and maintenance of microorganisms. Bacterial growth and effect of environment on growth of microorganisms. Dormancy in microorganisms. Role of microorganisms in food, dairy, fermentation and agriculture.

**Practical** : Isolation of microorganism and their microscopic examination. Staining procedure-simple, differential, negative, capsule and spore. Sterilization and preparation of culture media, enumeration of microorganisms and their identification.

**Micro. 426 Fundamentals of Soil Microbiology** **2+1** **Sem. II**

Soil as an environment for microorganisms and physico-chemical properties of soil. Occurrence of different groups of microorganisms in soil and their importance in agriculture, Biogeochemical cycles - C, N, P and S-cycles. Biological nitrogen fixation, its significance in agriculture. Microbiology of organic matter decomposition and humus formation. Phosphorus solubilization by microorganisms, mycorrhizae and its types. Pesticides and their effects on soil microflora. Biofertilizers and their use in agriculture.

**Practical** : Isolation, enumeration and characterization of different groups of soil microorganisms. Isolation and identification of symbiotic, non-symbiotic and P-solubilizing microorganisms. Isolation of pesticide resistant soil bacteria. Staining of VA mycorrhizae.

**Micro. 427 Fundamentals of Environmental Microbiology** **2+1** **Sem. II**

Microbial diversity-habitat and environment selection factors. Ecological niches. Survival of microorganisms-competition, adaptation. Intramicrobial and extramicrobial relationship-symbiotic relationship-lichens, rhizobium-legume, mycorrhizas, microbial-rumen, microbial insects. Microbial transformations - cycles of nature, biochemistry and energy production. Life in extreme environment - Archaebacteria-cell structure, biochemical and molecular adaptation. Enrichment of microorganisms from different environments. Microbial role in pollution-concept of BOD and COD, sewage and solid waste disposal, pesticide and xenobiotics. Drinking water BIS standards. Application of extermophiles, biogas production, bioplastics, composting, bioleaching, bioscrubbing, etc.

**Practical** : Enrichment of microorganisms from polluted environment-air, water, sewage etc. to study microbial diversity. Microbial relationship *in situ* condition. Winogradsky column. Determination of BOD and COD. Analysis of drinking water-biochemical and microbiological parameters. Growth characteristics of extreme microbes-halophiles and thermophiles. Biogas production in laboratory.

**Micro. 428 Fundamentals of Clinical Microbiology** **2+1** **Sem. II**

Host parasite relationship of infectious diseases, determinants of infectious diseases, attributes of pathogens and offending host-physical, chemical barriers and biological barriers, specific and non specific immune defense mechanisms of host, autoimmune diseases and allergic reactions. Introduction to pathogenic microbiology, epidemiology of infectious diseases, infectious disease cycle, transmission of infectious agents, surveillance, recognition, study and control of epidemics and nosocomial infection. Viral diseases, Characteristics of causal agents and disease control of selected diseases such as influenza, measles, yellow fever, rabies, poliomyelitis and AIDS. Microbial diseases of humans caused by Chlamydiae, rickettsiae, Gram positive and Gram negative organisms, human mycotic and parasitic protozoan infections.

**Practical** : Peripheral blood examination. Microscopy and morphological examination of important pathogens. Microbiological examination of sputum, urine, stool, wounds and pus. Isolation of bacteria and antibiotic sensitivity test.

## Postgraduate Courses

**Micro.-501 Techniques in Microbiology** **0+2** **Sem. I**

**Practical :** Awareness about lab safety measures, Study of general microbiological equipment, cleaning of glassware and apparatus for laboratory use, Methods of sterilization used in microbiology laboratory, Use of simple techniques in laboratory (Colorimetry, Centrifugation, electrophoresis and chromatography), Types of culture media, Isolation techniques and direct microscopic count, Environmental factors affecting bacterial growth: physical, chemical, temperature, pH, osmotic pressure, light (UV) and bacteriostatic agents, Bacteriology of air; water and soil, Characteristics of important types of micro-organisms: major functional groups of bacteria, lactic acid, spore forming and coliforms bacteria, fungi, yeast and mold, Assessment of microbial quality of portable water, Working in microscope and Staining techniques.

**Micro.-502 Principles of Microbiology** **3+1** **Sem. I**

**Unit I** Scope of microbiology, microbes and microbiologist. Emergence of special fields of microbiology.

**Unit II** The Germ theory of disease, Early studies : Pasteur's further contributions, Koch's contributions, Work toward controlling infections, Spontaneous generation theory.

**Unit III** Microscopy; Bright field, Dark field, Phase contrast, Confocal, Fluorescence, TEM, SEM – Working Principles and applications; Properties of light; Simple staining, differential and special staining.

**Unit IV** Evolutionary relationship among prokaryotes. Prokaryotes and Eukaryotes, Phylogenetic and numerical taxonomy. Species concept.

**Unit V** Use of DNA and r-RNA sequencing in classifications.

**Unit VI** Microbial growth and reproduction-communication, bacteria, yeast and virus growth, Replication, Cultivation methods, Normal micro flora of human body; Immune response specific and non-specific host resistance.

**Unit VII** Physical and chemical methods of sterilization.

**Unit VIII** Classification of microbes: electron, energy and carbon sources.

**Practical :** Working principles and handling of different types of microscopes – Bright and Dark field microscopy, Working principles and handling of different types of microscope – SEM and TEM, Methods of isolation from different environments – soil, water, milk and food, Use of selective media for isolation, Purification techniques of bacteria and fungi, Enumeration and Quantification techniques, Maintenance and preservation of cultures, Assessment of microbial quality of portable water, Morphological characterization of Bacteria, Morphological characterization of fungi, Biochemical characterization of bacteria, Biochemical characterization of fungus.

**Micro.-503 Microbial physiology and metabolism** **3+1 Sem. II**

**Unit I** Microbial nutrition - Chemical composition of microbial cell – Structure, function and assembly of cell membrane in prokaryotes, archaea and fungi - Macro and Micro- nutrients and their physiological functions – Transport of solutes across the membrane.

**Unit II** Microbial growth. Cell cycle and cell division. Bioenergetics - carbohydrate utilization via EMP, HMP, ED, TCA pathways, Aerobic and anaerobic respiration. Fermentative metabolism. Assimilation of nitrogen and sulphur - Oxygenic and anoxygenic photosynthesis-Mechanisms of carbon-dioxide fixation in prokaryotes. Ethanol, lactic acid, butanol, acetone and mixed acid fermentation. Fermentation of nitrogenous organic compounds, Regulation of microbial metabolism.

**Unit III** Effects of physical, chemical and other environmental factors on growth, Continuous culture, Diauxic growth and Synchronous culture. Method of growth measurement. Morphogenesis and cellular differentiation.

**Unit IV** Metabolic diversity in photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs. Nutritional grouping / classification of microorganisms. Bacterial endospore-types, morphology, biochemistry and regulation of formation and germination.

**Unit V** Enzyme kinetics: Michaelis Menten kinetics - mechanisms of inhibition of enzyme activity - coenzymes and prosthetic groups.

**Unit VI** Methods to determine free energy of biochemical reactions - high energy compounds. Microbial metabolism: generation of ATP, reducing power, development of proton gradient and biosynthesis of ATP.

**Unit VII** Biosynthesis of macromolecules – Synthesis and assembly of cell wall components – Methods of studying biosynthesis - regulation of microbial metabolism.

**Practical :** Use of simple techniques in laboratory (Colorimetry, Centrifugation, electrophoresis and GLC etc.), Determination of viable and total number of cells, Measurement of cell size, Gross cellular composition of microbial cell. Growth – Factors affecting growth, Study of bacterial spores and factors affecting germination, Enzyme activity and kinetics – calculating Km and Vmax of enzyme, Demonstration of thermos-, meso-, and psychrophilic micro-organisms, Production and testing of inducible enzymes in bacteria, Sporulation and spore germination in bacteria, Protoplasts formation and regeneration, Estimation of generation time and specific growth rate for bacteria and yeast, Diauxic growth curve, Production of synchronous cells, Effect of chemicals and environmental factors on bacterial growth, Isolation and Identification of reserve food material (Glycogen / polyphosphates, PHB) from bacteria (*Azotobacter, Bacillus megaterium*), Growth of microorganisms on various carbon and nitrogen sources.

**Micro.-504 Microbial Genetics** **2+1 Sem. I**

**Unit I** Introduction to Microbial genetics; Historically important events and major contributions of scientists in the field of Microbial genetics; Terminologies employed in microbial genetics and definitions; Nucleic acid-overview DNA, RNA.

**Unit II** Bacterial genome; Eukaryotic genome; Viral genome; Difference between prokaryotic and eukaryotic genome; Mechanisms and role of prokaryotic genome- an overview.

**Unit III** Structure of DNA–A form, B form, Z form; RNA- tRNA, mRNA, rRNA; Role and Replication of DNA and RNA; Enzymes involved in Replication and its role.

**Unit IV** Plasmids, Mitochondrial DNA, Chloroplast DNA- structure and function.

**Unit V** Gene structure and expression, principles of operon, gene expression in prokaryote and eukaryotes, intron and exons, post transcriptional modifications.

**Unit VI** Regulation of gene expression, negative expression (lac operon and trp operon), positive regulation (cAMP).

**Unit VII** Principles of mutation, spontaneous and induced mutation, different types of mutations, selection principles of mutants.

**Unit VIII** Mutagens and their mode of action, transposable elements and insertion sequences.

**Unit IX** DNA damage, DNA repair mechanisms in bacteria.

**Unit X** Genetic recombination in bacteria, mechanisms of recombination, transformation, conjugation, transduction.

**Unit XI** Gene cloning and gene sequencing. Impact of gene cloning, polymerase chain reaction, DNA sequencing, recombinant DNA technology.

**Practical :** Isolation of genomic DNA from pure cultures of bacteria and fungi, Visualization of mega plasmids of bacteria, Isolation of bacterial plasmids and Plasmid curing, Qualitative and quantitative assay of DNA by spectrometry and gel-electrophoresis, Inducing mutation by chemicals, physical and biological agents, Transformation and selection of transformants, Amplification of gene of interest by PCR – cloning and expression, Isolation of metagenomic DNA from environmental samples.

**Micro.-505 Soil Microbiology** **2+1** **Sem. II**

**Unit I** Landmarks in the history of soil microbiology. Abiotic factors (physical and chemical) affecting soil microflora as pH, chemicals, moisture, air, temperature etc.

**Unit II** Soil biota, Soil microbial ecology, types of organisms in different soils; Soil microbial biomass; Microbial interactions: unculturable soil biota.

**Unit III** Microbiology and biochemistry of root-soil interface; phyllosphere, plant growth promoting rhizobacteria, soil enzyme activities and their importance.

**Unit IV** Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and antimicrobials.

**Unit V** Biochemical composition and biodegradation of soil organic matter and crop residues.

**Unit VI** Endophytic microorganisms, Mycorrhizae, types and role in phosphate mobilization. Potassium releasing bacterium. Microbes in biotic and abiotic stress management.

**Unit VII** Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development.

**Practical :** Determination of soil microbial population, Determination of Soil microbial biomass, Decomposition studies in soil, Soil enzymes, Measurement of important soil microbial processes such as ammonification, nitrification, $N_2$ fixation, S oxidation, P solubilization and mineralization of other micro nutrients, Study of rhizosphere effect, Microbial diversity Endophytic microorganisms, Mycorrhizae, types and role in phosphate mobilization Potassium releasing bacterium, Microbes in biotic and abiotic stress management.

**Micro.-506 Microbial Biotechnology** **2+1** **Sem. II**

**Unit I** Introduction, Scopes, historical development, application and challenges.

**Unit II** Fermentative metabolism, isolation, preservation screening and genetic improvement of industrially important microbes; Microbial growth kinetics.

**Unit III** Fermenters – types of fermenter, stirred tank reactor, bubble column reactor, airlift reactor, packed bed reactor, fluidized bed reactor and trickle bed reactor, agitation and aeration in a reactor, mass transfer. Foam formation and control.

**Unit IV** Types, Batch, Fed batch and continuous fermentation- multistage system. Solid state fermentation, Overproduction of primary and secondary metabolites e.g. amino acids, organic acids, alcohols, enzymes, organic solvents, antibiotics, etc. Immobilization of enzymes; and cells; Scale-up principles; Down-stream processing etc.

**Unit V** Current advances in production of antibiotics, vaccines, and biocides; Steroid transformation; Bioprocess engineering; Production of recombinant DNA products, Immobilization techniques.

**Unit VI** Production of alcohol (ethanol, wine and beer) and improvement by genetic engineering. Microbial production of acids (citric, acetic and gluconic acid) solvents (glycerol acetone and butanol) aminoacids (lysine and glutamic acid).

**Unit VII** Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines;

Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Microbial polysaccharides: fermentative production of xanthan gums. Bacterial bioplastics, genetic engineering of microorganisms for the production of poly-3 hydroxyalkanoates. Single cell protein, Bio-insecticides; Bio-fertilizers; Waste as source of energy/food Microbiologically-produced food, colours, and flavours. Retting of flax. Recent advances in microbial biotechnology.

**Practical :** Isolation and maintenance of industrially important microbes, Production of alcohol, Production of beer, Production of citric acid, Production of lactic acid, Standardization of physical factors for the higher production of citric acid, Production and assay of antibiotics, Production of pullulan, SCP production, Study of bioreactors and their operation.

**Micro.-507 Food Microbiology** **2+1** **Sem. I**

**Unit I** Introduction and scope; Food Microbiology, Important microorganisms in food and their sources. Importance and significance of microorganisms in food.

**Unit II** Intrinsic and extrinsic factors influencing microbial growth in foods; Spores and their significance; Indicator organisms and Microbiological criteria.

**Unit III** Microbial spoilage of meat, milk, fruits, vegetables and their products. Food-borne pathogens (bacteria, fungi and viruses) and intoxication.

**Unit IV** Fermented dairy, vegetable, meat products.

**Unit V** Physical methods, chemical preservatives and natural antimicrobial compounds. Biologically based preservation systems. Foods for Specified Health: Probiotic bacteria; Bifidus factor. Bacteriocins and their applications; Pre-, probiotics and synbiotics. Microbes as food: single cell protein.

**Unit VI** Food safety and Quality Management Systems- General principles of food safety risk management, Recent concerns on food safety- Safe food alternatives (Organic foods), Good agricultural Practices (GAP), Food Indicators of water and food safety and quality. Advanced techniques in detecting food-borne pathogens and toxins. HACCP (Hurdle technology and Hazard analysis. Critical control point) CODEX, FSSAI (Food Safety and Standard Authority of India) systems in controlling microbiological hazards in foods. Food safety regulations.

**Practical :** Statutory, recommended and supplementary tests for microbiological analysis of various foods, Infant foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers, normal, spoiled, processed, fermented food and water, Testing of antimicrobial agents, Analysis of water, HACCP Plan, Visit to Food processing Industries.

**Micro.-508 Bacteriophages** **1+1** **Sem. II**

**Unit I** Historical developments and classification of bacteriophages.

**Unit II** Physiology, biochemistry, enzymology and molecular biology of phage- bacterial interactions.

**Unit III** Structure, functions and life cycles of P2 phage, Lambda phage, M13 phage, ϕX174 phage.

**Unit IV** Phages in the development of molecular biology and genetic engineering.

**Practical :** Titration of phages and bacteria, Absorption of phages, Preparation of phage stocks, Isolation of new phages and phage resistant bacteria, One step growth curve, phage bursts, Induction of lambda, Complementation of T4rII mutants etc.

**Micro.-509 Environmental Microbiology** **2+1** **Sem. I**

**Unit I** Scope of environmental microbiology, Microbial ecology: Microbial evolution and biodiversity – Ecological niches – Definitions, biotic and abiotic environment. Environmental segments. Composition and structure of environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics, structure and function. Food chains, food webs and trophic structures. Ecological pyramids.

**Unit II** Microorganisms and their natural habitats: Aeromicrobiology, Astrobiology, Methane and chlorates on Mars, terrestrial analogues. Biofilms and microbial mats, Aquatic ecosystems- Public Health Microbiology.

**Unit III** Extremophiles: Definition and ecological aspects. Thermophiles, Xerophiles, Psychrophiles, Piezophiles, Alkaliphiles, Acidophiles- Halophiles and Barophiles. Environmental Distribution and Taxonomic Diversity, Physiology, Adaptive mechanisms, Enzymes, Applications.

**Unit IV** Biogeochemical cycling and its consequences. Global environmental problems.

**Unit V** Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Anaerobic processes-Bioremediation of nuclear wastes. Bioconversion of Solid Waste and utilization as fertilizer. Bioaccumulation of heavy metal ions from industrial effluents. Biomining. Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay behavior.

**Unit VI** Microbial upgradation of fossil fuels and coal gas. Microbial interaction in rumen and gastrointestinal tract.

**Practical :** Determination of indices of pollution by measuring BOD/COD of different effluents, Analysis of natural waters, Quality control tests, waste treatment and anaerobic digestion, Demonstration of waste water treatment processes such as activated sludge processes, biofilter and fluidized bed process, Bacterial reduction of nitrate from ground waters, Isolation and purification of degradative plasmid of microbes growing in polluted environments, Recovery of toxic metal ions of an industrial effluent by immobilized cells, Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste], Biotransformation of toxic metal ions into non-toxic metals ions, Microbial dye decolourization / adsorption, Biotrap based isolation of selective functional microbes, Thermophlic enzyme in biomass deconstructions, Halophilic microbes from salt lake-Pesticide degradation by microbes.

**Micro.-510 Industrial Microbiology** **2+1** **Sem. II**

**Unit I** Introduction to Industrial Microbiology. Sources and characters of industrially important microbes; their isolation, purification and maintenance. types of fermentation and fermenters. Microbial growth kinetics in batch, continuous and fedbatch fermentation process.

**Unit II** Bioreactors: Types and configuration. Microbiology and production of alcoholic beverages; Malt beverages, distilled beverages, wine and champagne; Commercial production of organic acids like acetic, lactic, citric, and gluconic acids Commercial production of important amino acids (glutamic acid, lysine and tryptophan), vitamins (riboflavin and vitamin A), enzymes, antibiotics and single cell proteins.

**Unit III** Biocontrol agents and Biopesticides: Biocontrol agents and their scope in control of plant diseases, nematodes and insect pests. Role of bioagents in sustainable agriculture.

**Unit IV** Introduction & industrial production of Bioplastics: Microorganisms involved in synthesis of biodegradable plastics and microbial pigments and biopolymers. Biosensors: Development of biosensors to detect food contamination and environment pollution. Biofuels: Production of ethanol, biogas and hydrogen from organic residues, fuels from algae; Mushroom cultivation.

**Unit V** Genetic engineering of microbes, Role of recombinant microbes in industrial sectors for enhanced production of valuable products. Mechanisms of pesticide degradation by microbes.Biomining: Coal, mineral and gas formation, prospecting for deposits of crude, oil and gas, recovery of minerals from low-grade ores.

**Practical :** Isolation and purification of industrially important microbes (Bacteria, fungus and yeasts), Production of industrial compounds such as alcohol, beer, citric acid, lactic acid acetic acids gluconic acid and their recovery, Demonstration of biogas production, Production and assay of enzymes, organic acids and pigments, Mass production of biocontrol agent, Visit to industries.

**Micro.-511 Biofertilizer Technology** **2+1** **Sem. I**

**Unit I** Different agriculturally important beneficial microorganisms: Chemical Vs Biofertilizers: Current Scenario in biofertilizer technology in world-In India, List of biofertilizers-their application in agriculture Brief introduction about Agriculturally beneficial microorganisms (free- living, symbiotic (rhizobial, actinorhizal), associative and endophytic nitrogen fixers including phosphobacteria, cyanobacteria, their types and

importance, taxonomic classification, Nitrogen fixing biofertilizers: nodule formation, competitiveness and quantification of $N_2$ fixed and their use.

**Unit II** Different agriculturally important beneficial microorganisms: Mechanism of phosphorous solubilization by photobacteria , Bacteria for potassium, zinc and sulphur nutrition.

**Unit III** Different agriculturally important beneficial microorganisms: Plant growth promoting rhizobacteria, FCO norms and biofertilizer production and usage at national and international levels.

**Unit IV** Different agriculturally important beneficial microorganisms: Biocontrol microbial inoculants. Requirements for establishing bioinoculants production unit. Economics of biofertilizers production. Constraints in biofertilizers production and usage.

**Unit V** Different agriculturally important beneficial microorganisms for recycling of organic waste and composting, biomediators and other related microbes.

**Unit VI** Different agriculturally important beneficial microorganisms :Selection, establishment, competitiveness, crop productivity, soil & plant health, mass scale production and quality control of bio inoculants. Biofertilizer inoculation and microbial communities in the soil. Different formulations of biofertilizers. Advantages and limitations of Liquid formulations, BIS standards of biofertilizers.

**Practical :** Isolation of phosphate solubilizing microorganisms, *Azotobacter* and *Azospirillum*, Development and production of efficient microorganisms, Determination of beneficial properties in important bacteria to be used as biofertilizer, Nitrogen fixing activity, indole acetic acid (IAA), siderophore production etc., Bioinoculant production and quality control, Population dynamics in broth and carrier materials during storage, Development of cultures from starter, Preparation of broth for large scale cultivation in fermenter/ large containers. Inoculation and development of culture, Mass production of carrier based and liquid biofertilizers, Mass production of important two or three biocontrol agents (*Trichoderma viride*, *Pseudomonas fluorescens* and *Metarhizium anisopliae*): Form, dose and method of application, Mass production of AM fungi in pot and root organ culture, Quality control and BIS standards, Mass production of Azolla and BGA, Visit to a biofertilizer production plant

**Micro.-512 Cyanobacterial and algal Biotechnology** **2+0** **Sem. II**

**Unit I** Introduction to cyanobacteria and algae. Definition, occurrence and distribution, thallus structure, reproduction, life cycles, origin and evolution of cyanobacteria, molecular evolution; role of algae in evolution of land plants and horizontal transfer of genes. Brief classification of algae: different classes, occurrence and distribution.

**Unit II** Algal pigments, storage products, physiology and metabolism including photosynthesis.

**Unit III** Ecology of algae –primary colonizers and cycling in soil and water. Cellular differentiation and nitrogen fixation, nitrogen metabolism carbon metabolism.

**Unit IV** Algal culturing and cultivation. Culture types, culture conditions, culture vessels, culture media, sterilization, culture methods, synchronous cultures, photobioreactors, algal density and growth, seaweed cultivation.

**Unit V** Cyanobacterial and algal fuels, Fine chemicals (restriction enzymes etc.) and nutraceuticals from algae; UV absorbing pigments Industrial products from macro algae – seaweed biotechnology, sustainable aquaculture. Ecology of algae- distribution in soil and water; primary colonizers, carbon sequestration and cycling in soil and water. Cellular differentiation and nitrogen fixation, nitrogen metabolism.

**Unit VI** Algae in pollution control - as pollution indicators, eutrophication agents and role in Bioremediation and reclamation of problem soils. Cyanobacterial and algal toxins, allelopathic interactions, Algae in global warming and environmental sustainability. Cyanobacteria and selected microalgae in agriculture – biofertilizers & algalization; soil conditioners; reclamation of problem so ls.

**Micro.-513 Biology and Cultivation of Edible Fungi** **2+1** **Sem. II**

**Unit I** History of mushroom cultivation technology, nutritional, medicinal and agricultural importance of edible fungi.

**Unit II** Classification of commonly cultivated edible taxa, their characterization based on morphological and anatomical features.

**Unit III** Basic morphology of a typical mushroom and the exceptions, physiology of growth and fruiting, environmental factors affecting their growth, nutritional requirements of edible taxa.

**Unit IV** Life cycle studies of *Agaricus, Volvariella, Calocybe, Pleurotus and Lentinus*. Sexuality and breeding of commonly cultivated edible taxa, strain improvement studies through conventional/non-conventional techniques.

**Unit V** Substrate preparation and cultivation techniques of *Agaricus, Volvariella, Pleurotus* and speciality mushrooms (*Auricularia, Lentinus and Calocybe*).

**Unit VI** Common pests, diseases (bacterial, fungal, viral) of mushrooms, their prevention and treatment; common disorders of mushrooms due to environmental irregularities, their prevention and treatment.

**Unit VII** Post harvest technology for improvement in shelf life of mushrooms- washing, steeping, blanching, drying and packaging.

**Practical :** Micro/macroscopic characteristics of important genera, Preparation and maintenance of spore and tissue cultures and spawn making, Compost preparation by long and short method, Cultivation of important genera (*Agaricus, Calocybe indica, Pleurotus, Volvariella, Auricularia and Lentinus edodes*), Production, extraction and estimation of extracellular enzymes, Isolation of single spore isolates (SSI's), *In vivo* somatic hybridization for mushroom strain improvement, Visit to a commercial mushroom growing unit.

**Micro.-514 Clinical Microbiology** **2+1** **Sem. I**

**Unit I** Biological properties of etiological agents; disease cycle, pathogenicity; laboratory diagnosis; epidemiology; clinical manifestation; gross and histopathological changes in the tissues; methods of transmission infection; factors predisposing to microbial pathogenicity, epidemiology.

**Unit II** Immunity and prophylaxis against diseases; active immunity; passive immunity; Antigen antibody interaction. Use of various vaccines/non-conventional vaccines.

**Unit III** Immunoglobulin diversity; Affinity of antigen antibody interaction and its biological significance; Molecular basis of immunogenicity and antigenicity.

**Unit IV** Haemolytic streptococcal infection and pneumonia.

**Unit V** Infections by *Escherichia*, *Shigella*, *Salmonella*, *Vibrio.*

**Unit VI** Pertussis, Chlamydia, Tuberculosis.

**Unit VII** Blastomycosis, Histoplasmosis, Coccidiodomycosis, Aspergillosis, Candidiasis.

**Unit VIII** Athlete's foot, Ringworm, Jock itch and Yeast infections.

**Unit IX** Atinomycosis.

**Unit X** Human Immunodeficiency, Influenza, Polio, Rabies.

**Unit XI** Causative agent; Morphology; Resistance; Pathogenesis; Host and Cultivation; Lab diagnosis; Treatment.

**Unit XII** Malaria, Amoebiasis, Trypanosomiasis.

**Practical :** Culturing of clinical specimens, Biochemical identification of clinical isolates, Serological tests, Microbiological examination of sputum/saliva, Microbiological examination of urine, Microbiological examination of blood/skin, Biochemical-Typing of pathogenic bacteria, Gel precipitation test for bacterial toxins.

**Micro.-591 Seminar** **1+0**

**Micro.-599 Master's Research** **0+30**

## Ph.D. courses

**Micro.-601 Improvements in Fermentation Technology 2+1 Sem. II**

**Unit I** Definition of fermentation – rise of fermentation technology –current trends in fermentation industry – scope and importance of fermentation technology.

**Unit II** Continuous, batch and fed batch culture –anaerobic fermentation - range of fermentation process – microbial growth cycle – diauxic growth – growth kinetics – substrate uptake, kinetics (Jacob and Monod) - primary and secondary metabolites – future prospects of fermentation microbiology

**Unit III** Peripheral parts and accessories – alternative vessel designs, containment in fermentation, fermenter preparation and use, aeration and agitation, instrumentation and control, biosensors in monitoring, computer applications in fermentation technology

**Unit IV** Solid state and submerged fermentation, acidic/alcoholic fermentation, recovery of product, effluent treatment, Economics of fermentation

**Unit V** New strategies for isolation of industrially important microbes and their genetic manipulations; Antibiotic fermentation research; steroid transformation; Yeast technology – classification, genetics, strain improvement for brewing, baking and distilleries

**Practical :** Studying the various components of fermenter, exposure to different types of fermenter, sterilization and operating procedures, designing the production medium, isolation and purification of industrially important microbes, Genetic manipulations in microbes, Fermentation by improved strains of yeast for production of alcohol, microbial production of enzymes by solid state fermentation, Microbial production of important antibiotics, Bioremediation of industrial effluents

**Micro.-602 Microbial Physiology and Regulation 2+0 Sem. II**

**Unit I** Origin, evolution, structure, function and molecular aspects of various cell components. Differentiation in bacteria, slime molds, yeasts. Molecular biology of bioluminescence, bacterial virulence. Heat shock response. Extracellular protein secretion in bacteria.

**Unit II** Regulation of initiation, termination and anti-termination of transcription. Global regulation and differentiation by sigma factor. Regulatory controls in bacteria - inducible and biosynthetic pathways. Oxidative stress control. Fermentative and respiratory regulatory pathways.

**Unit III** Ribosomal RNA and ribosomal proteins regulation under stress condition. Specific regulatory systems; SOS regulatory control; Antisense RNA regulation of gene expression. Biosynthesis of micromolecules (Nucleotides and Aminoacids) macromolecules (DNA, RNA, Proteins) Global nitrogen control and regulation of nitrogen fixation

**Unit IV** Topics of current interest in Molecular microbiology and regulatory systems.

**Micro.-603 Recent Development in Soil Microbiology 2+0 Sem. II**

**Unit I** Molecular ecology and biodiversity of soil microorganisms; Survival and dispersal of microorganisms. Interaction between agricultural chemicals, pollutants and soil microorganism

**Unit II** Successions and transformation of organic matter, Role of microorganisms in soil fertility. Soil health and quality: Microbial indicators

**Unit III** Bioremediation of polluted soils; Biological control. Other topics of current interest.

**Micro.-604 Recent Approaches in Environmental Microbiology 2+0 Sem. I**

**Unit I** Types of environmental pollution; problems arising from high-input agricultural residues. Air and water pollution.

**Unit II** Waste water treatment -physical, chemical, biological and microbial processes; need for water and natural resource.

**Unit III** Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals, detergents etc.; aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating

drums, etc.); anaerobic processes: digestion, filtration, etc.

**Unit IV** Conventional fuels and their environmental impact.

**Unit V** Energy from solid waste; biogas; land filling, microbial hydrogen production; use of agro industrial waste, agricultural waste for sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture, etc.

**Unit VI** Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by micro-organisms.

**Unit VII** Ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; Microbial and biotechnological approaches for the management of environmental problems.

**Micro.-605 Plant Microbe Interactions** **2+1** **Sem. I**

**Unit I** Plant-microbe, microbe-microbe, soil- microbe, soil-plant-microbe interactions leading to symbiotic (rhizobial and mycorrhizal, Azolla-Anabaena), associative, endophytic and pathogenic interactions.

**Unit II** Types of ecosystems: Concept and dynamics of ecosystem, Food chain and energy flow, Microbial communities in the soil. Community dynamics and population interactions employing DGGE, TGGE, T-RFLP.

**Unit III** Quorum-sensing in bacteria, flow of signals in response to different carbon or other substrates and how signals are recognized

**Unit IV** Methodology/resources to study plant-microbe interaction, biosensors, transcriptome profiling, metabolic profiling, genomics, and proteomics Induced systemic resistance against pathogens and tolerance against abiotic stress: Molecular basis; Molecular diversity of microbes, plants and their interactions including transgenic microbes and plants

**Practical :** Phylochip based microbial community analyses, Endophytic and phyllosphere microbial community, PCR-DGGE-Rhizosecretion, Secretome -FT-IR, HPLC, Multifunctional protein identification and characteriation-2DE, MALDI-TOF, Examination of mycorrhizal infection in roots of different plants, Characterization of PGPR; Quantification of siderophores, HCN and IAA

**Micro.-606 Advances in Microbial Genetics and Biotechnology** **2+0** **Sem. I**

**Unit I** Genetic material organization in prokaryotic and eukaryotic cell

**Unit II** Gene expression - DNA – protein interactions.

**Unit III** General and specific recombination following gene transfer - transformation, transduction and conjugation.

**Unit IV** Bacterial plasmids - replication, maintenance and functions.

**Unit V** Bacteriophages-structure, lytic and lysogenic cycle, molecular mechanism of adsorption and infection.

**Unit VI** Insertion sequences and transposons-structure, replication and application in improvement of microbial expression with respect to industry and agriculture.

**Unit VII** Molecular mechanism of site specific mutagenesis.

**Unit VIII** Recombinant DNA technology- DNA isolation, vector designing, cloning, PCR amplification, expression of genes

**Unit IX** Application of molecular mechanisms in industry/agriculture.

**Unit X** Protein Engineering. Concepts of proteomics and genomics.

**Micro.-691 Seminar I** **1+0**

**Micro.-692 Seminar II** **1+0**

**Micro.-699 Ph.D Research** **0+75**

# ZOOLOGY

## PROGRAMMES

**M.Sc.**
**Ph.D.**
**Five Year Integrated M.Sc. (Hons.)**

## COURSE REQUIREMENTS

### M.Sc.

| | |
|---|---|
| Fields of specialization | Ecology and Animal Physiology, Biosystematics and Biodiversity, Parasitology, Vertebrate Pest Management |
| Required courses | Zoo.-501, Zoo.-502, Zoo.-503, Zoo.-504, Zoo.-505 |
| Supporting Courses | Stat.-502 and as per BSMA as well as from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Biochemistry, Biotechnology, Botany, Entomology, Nematology, Food Science and Technology or any other as approved by the Dean, Postgraduate Studies. |
| Deficiency courses | As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies. |

### Ph.D.

| | |
|---|---|
| Fields of specialization | Ecology and Animal Physiology, Biosystematics and Biodiversity, Parasitology, Vertebrate Pest Management |
| Required courses | Zoo.-601, Zoo.-602, Zoo.-604 |
| Supporting Courses | As per BSMA as well as from subject matter fields (other than minor) relating to area of special interest and research problem. |
| Minor fields | Biochemistry, Biotechnology, Botany, Entomology, Nematology, Food Science and Technology or any other as approved by the Dean, Postgraduate Studies. |
| Deficiency courses | French-501 and others as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies |

### Five Year Integrated M.Sc. (Hons.)

| | |
|---|---|
| Fields of specialization | Ecology and Animal Physiology, Biosystematics and Biodiversity, Parasitology, Vertebrate Pest Management |
| Required courses | All courses listed for Semester I-VI and Zoo.-501, Zoo.-502, Zoo.-503, Zoo.-504, Zoo.-505 |
| Supporting courses | Stat.-502 and as per BSMA as well as from subject matter fields (other than minor) relating to area of special interest and research problem. Stat-502 and as per BSMA as well as from subject matter fields (other than minor) relating to area of special interest and research problem |
| Common Courses | PGS-501, PGS-502, PGS-503, PGS-504, PGS-505 |
| Minor fields | Biochemistry, Biotechnology, Botany, Entomology, Nematology, Food Science and Technology or any other field as approved by the Dean, Postgraduate Studies. |
| Deficiency courses | As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies. |

# DESCRIPTION OF COURSE CONTENTS

## Undergraduate Courses/Integrated M.Sc. (Hons)

**Zoo. 51 Fish Production** **1+1** **Sem. II**

Importance of fish and fisheries. Types of fisheries: capture and culture fishery. Fishing gears and crafts. Scope of Inland fisheries in the agro-climatic regions of Punjab. Survey of fish fauna: indigenous and exotic/introduced species. Fishes of economic importance. Selection of fish for culture purposes. Management of typical fish farm. Fish nutrition and feeding. Techniques of induced breeding and their importance. Production of fish seed. Fish hatcheries and their importance. Economic importance of fish. Fish diseases. Integrated fish farming. Introduction to fish post-harvest technology.

**Practical :** Determination of water quality parameters - turbidity, pH, dissolved oxygen etc. Qualitative and quantitative analysis and identification of phyto- and zooplankton. Anatomy of fish, identification of culturable fishes. Fish predators. Fish feeds. Identification of fishing gears/nets. Induced breeding techniques. Production of fish seed. Visit to an operational fish farm.

**Bio. 91 Introductory Biology** **3+1** **Sem. I**

Diversity in Living World - What is living, Biodiversity, Need for classification, Three domains of life, Taxonomy & Systematics. Concept of species and taxonomical hierarchy, Binomial nomenclature, Tools for study of Taxonomy, Museums and Zoos. Five Kingdom classification - salient features and classification of Monera, Protista and Fungi into major groups. Lichens, Viruses and Viroids. Salient features and classification of plants into major groups - Algae, Bryophytes, Pteridophytes, Gymnosperm and Angiosperm (three to five salient and distinguishing features and at least two examples of each category). Angiosperms-classification up to class, characteristics features and examples. Structural organization in animals and salient features and classification of Animals – non-chordate up to phyla level and chordate up to class level (three to five salient features and at least two examples). Structural organization in plants - morphology and modifications, functions of different parts of flowering plants - root, stem, leaf, flower, fruit and seed. Inflorescence - cymose and racemose. Morphology, anatomy and functions of different systems (digestive, circulatory, respiratory, nervous and reproductive) of an insect (cockroach) (Brief account only).

**Practical** : Study of parts of a compound microscope. Study of the specimens and identification with reasons - Bacteria, Oscillatoria, Spirogura, Rhizopus, Mushroom, Yeast. Study of the specimens and identification with reasons - liverwort, moss, fern, pine, one monocotyledonous plant, one dicotyledonous plant and one lichen. Study and describe three locally available common flowering plants from each of the following families (Solanaceae, Fabaceae and Liliaceae) including dissection and display of floral whorls, anther and ovary to show number of chambers. Types of root (tap and adventitious), stem (herbaceous and woody) and leaf (arrangement, shape, venation, simple and compound). Study of different modifications in root, stem and leaves. Study and identification of different types of inflorescence. Study of specimens and identification with reasons - Amoeba, Hydra, Liverfluke, Ascaris, Leech, Earthworm, Prawn, Silkworm, Honeybee, Snail and Starfish. Study of specimens and identification with reasons - Shark, Rohu, Frog, Lizard, Pigeon and Rabbit.

**Bio. 92 Cell Structure and Function** **3+1** **Sem. I**

Cell structure and function (Introduction). Cell theory and cell as the basic unit of life. Structure of prokaryotic and eukaryotic cell. Plant cell and animal cell - cell membrane and cell wall. Cell organelles structure and function - endomembrane system, endoplasmic reticulum, golgi bodies, lysosomes, vacuoles, mitochondria, ribosomes, plastids and microbodies. Cytoskeleton - cilia, flagella and centrioles (Ultrastructure and function). Chemical constituents of living cells: biomolecules - structure and function of proteins, carbohydrates, lipid and nucleic acids. Enzymes - types, properties and enzyme action. Cell division - cell cycle, meiosis, mitosis and their significance. Plant tissues - anatomy of root, stem and leaf. Animal tissues.

**Practical** : Study of tissues and diversity in shapes and sizes of plant (e.g. palisade cells, guard cells, parenchyma, collenchyma, sclerenchyma, xylem and phloem) through temporary/permanent slides. Study of diversity in shapes of animal cells through temporary/permanent slides. Study of tissue - squamous epithelium, muscle fibers and mammalian blood smear through temporary/permanent slides. Study of mitosis in onion root tip cells from permanent slides. Study of mitosis in animal cells (grasshopper) from permanent slides. Preparation and study of T.S. of dicot and monocot roots (primary). Preparation and study of T.S. of dicot and monocot stems (primary).

**Bio. 93 Genetics and Evolution/Biology III** **3+1** **Sem. I**

Heredity and variation: Mendelian Inheritance, deviations from Mendelism - incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups. Pleiotropy. Elementary idea of polygenic inheritance. Chromosome theory of inheritance. Chromosomes and genes. Sex linked inheritance - haemophilia, colour blindness. Sex determination - in humans, birds and honey bee. Linkage and crossing over. Mendelian disorders in humans - Thalassemia. Chromosomal disorders in humans - Down's syndrome, Turner's and Klinefelter's syndromes. Molecular basis of inheritance: search for genetic material and DNA as genetic material. Structure of DNA and RNA, DNA packaging and DNA replication. Central dogma - transcription, genetic code, translation. Gene expression and regulation - Lac Operon. Genome and human genome project. DNA finger printing. Evolution: origin of life, biological evolution and evidences for biological evolution (paleontological, comparative anatomy, embryology and molecular evidence). Darwin's contribution, modern synthetic theory of evolution, mechanism of evolution - variation (mutation and recombination) and natural selection with examples, types of natural selection. Gene flow, genetic drift, Hardy-Weinberg's principle. Adaptive Radiation, Human evolution.

**Practical :** Study of prepared pedigree charts of genetic traits such as rolling of tongue, blood groups, widow's peak, colour blindness. Study of analogous and homologous organs in various animals. Study of Mendelian inheritance using seeds of different size of any plant. Exercise on controlled pollination - emasculation, tagging and bagging.

**Bio. 94 Ecology and Environment** **3+1** **Sem. I**

Ecology and environment. Organisms and environment: habitat and niche. Population and ecological adaptations. Population interactions - mutualism, competition, predation and parasitism. Population attributes - growth, birth rate and death rate, age distribution. Ecosystems: patterns, components, productivity and decompositions. Energy flow, Pyramids of number, biomass, energy. Nutrients cycling (carbon and phosphorous). Ecological succession. Biodiversity and its conservation: concepts of biodiversity, patterns of biodiversity, importance of biodiversity, loss of biodiversity, biosphere reserves, national parks and sanctuaries. Hotspots, endangered organisms, extinction, Red Data Book. Environmental issues: air pollution and its control, water pollution and its control, agrochemicals and their effects, solid waste management, radioactive waste management, greenhouse effect and global warming, ozone depletion, deforestation. Any three case studies as success stories addressing environmental issues.

**Practical** : Collection of water from different water bodies and study them for pH clarity and presence of any living organisms. Study of animals found in xerophytic conditions and comment upon their adaptation ecosystem. Study of animals found in aquatic conditions and comment upon their adaptation ecosystem. Identification of common disease causing organisms like Ascaris, Entamoeba, Plasmodium, Ringworm and to study symptoms of diseases that they cause through permanent slides or specimens. Collect soil from different sites and study them for texture and moisture content. Study the pH and water holding capacity of soil correlating with the kinds of plants found in them. Study the presence of any suspended particulate matter in air at the two widely different sites. Study of plant population density by quadratic method. Study of plant population frequency by quadrate method. Study of plants found in xerophytic conditions and comment upon their adaptation ecosystem. Study of plants found in aquatic conditions and comment upon their adaptation ecosystem.

**Zoo. 91 Basics of Animal Physiology** **3+1** **Sem. II**

Digestion and absorption: alimentary canal and digestive glands, role of digestive enzymes and gastrointestinal hormones, peristalsis, digestion, absorption and assimilation of proteins, carbohydrates

and fats, egestion. Nutritional and digestive disorders- PEM, indigestion, constipation, vomiting, jaundice, diarrhoea. Breathing and respiration: respiratory organs in animals, respiratory system in humans, mechanism of breathing and its regulation in humans - exchange of gases, transport of gases, regulation of respiration, respiratory volumes. Disorders related to respiration - asthma, emphysema, occupational respiratory disorders. Body fluids and circulation: composition of blood, blood groups, coagulation of blood, composition of lymph and its function. Human circulatory system - structure of human heart and blood vessels. Cardiac cycle, cardiac output, ECG, double circulation, regulation of cardiac activity. Disorders of circulatory system - hypertension, coronary artery disease, angina pectoris, heart failure. Excretory products and their elimination: modes of excretion- ammonotelism, ureotelism, uricotelism. Human excretory system - structure and function, urine formation, osmoregulation, regulation of kidney function - renin-angiotensin, atrial natriuretic factor, ADH and diabetes insipidus. Role of other organs in excretion. Disorders- uraemia, renal failure, renal calculi, nephritis, dialysis and artificial kidney. Locomotion and movement: types of movement - ciliary, flagellar, muscular. Skeletal muscle - contractile proteins and muscle contraction. Skeletal system and its functions, joints. Disorders of muscular and skeletal system - myasthenia gravis, tetany, muscular dystrophy, arthritis, osteoporosis, gout. Neural control and coordination: neuron and nerves. Nervous system in humans - central nervous system, peripheral nervous system and visceral nervous system. Generation and conduction of nerve impulse, reflex action. Sense organs: sensory perception, elementary structure and function of eye and ear. Chemical coordination and regulation: endocrine glands and hormones. Human endocrine system - hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal, pancreas, gonads. Mechanism of hormone action, role of hormones as messengers and regulators, hypo- and hyperactivity and related disorders (common disorders e.g. dwarfism, acromegaly, cretinism, goiter, exopthalmic goiter, diabetes, Addison's disease). Diseases related to all the human physiology systems in brief.

**Practical :** Test the presence of urea in urine. Detect the presence of sugar in urine/ blood sample. Detect the presence of albumin in urine. Detect the presence of bile salts in urine. General study of human skeleton. Study of skull and jaw bones (upper and lower). Study of ribs. Study of vertebrae. Study of forelimb. Study of hind limb.

**Zoo. 92 Animal Reproduction and Human Welfare** **3+1** **Sem. II**

Reproduction: Human reproduction - male and female reproductive systems, microscopic anatomy of testis and ovary. Gametogenesis - spermatogenesis and oogenesis. Menstrual cycle. Fertilization, embryo development upto blastocyst formation,implantation. Elementary idea of pregnancy and placenta formation, parturition, lactation. Reproductive health: need for reproductive health and prevention of Sexually Transmitted Diseases (STD). Birth control - need and methods, contraception and Medical Termination of Pregnancy (MTP). Amniocentesis. Infertility and Assisted Reproductive Technologies - IVF, ZIFT, GIFT. Biotechnology and its applications: principles and processes of biotechnology, genetic engineering (recombinant DNA technology). Application of biotechnology in health, human insulin production, gene therapy. Genetically modified organisms - transgenic animals. Biology and human welfare. Health and diseases: pathogens, parasites causing human diseases (malaria, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm). Basic concepts of immunology. Vaccines, Cancer, HIV and AIDS. Adolescence, drug and alcohol abuse. Apiculture and animal husbandry. Microbes in human welfare: in household food processing, industrial production, sewage treatment, energy generation and as biocontrol agents and biofertilizers.

**Practical** : Study and identify stages of gamete development i.e. T.S. of Testis and T.S. of Ovary through permanent slides. Study of meiosis in grasshopper testis through permanent slides. Study of T.S. of Blastula through permanent slides. Identify Ascaris, Entamoeba, Plasmodium and Ringworm - comment on symptoms of diseases that they cause through permanent slides or specimens.

**Bio. 101 Introduction to Biology** **3+0** **Sem. I**

Plant kingdom, features of each group, parts of angiospermic plants, morphology of plant parts, pollination and fertilization, fruit and seed. Introduction to photosynthesis and respiration. Process of growth and development. Cell structure, differences between plant and animal cell, cell division and biomolecules. Simple and compound tissues. Functional organization of a mammal. Development of frog upto three germinal layers. Classification and general survey of animal kingdom.

**Bio. 102 Introductory Biology** **1+1 Sem. I**

Introduction to the living world, diversity and characteristics of life, origin of life, evolution and eugenics. Binomial nomenclature and classification. Cell and cell division. Morphology of flowering plants. Seed and seed germination. Plant systematic – viz., Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

**Practical :** Morphology of flowering plants - root, stem and leaf and their modifications. Inflorescence, flower and fruits. Cell, tissues and cell division. Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants - Brassicaceae, Fabaceae and Poaceae.

**Bio. 103 Biodiversity and its Conservation** **2+0 Sem. II**

Concept of biodiversity, bioresource and wildlife management. Conservation strategies - in situ and ex situ conservation - wildlife conservation projects in India, protection of biodiversity for its suitable utilization, threats to biodiversity. WCU Red Data book. Biodiversity hotspots in India. National bureaus of genetic resources. Sustainable development. Diversification of crops and cropping system vis-a-vis maintenance of on farm biodiversity. Centres of origin of crops, diversity of indigenous livestock and crops. Vulnerability and extinction of flora and fauna. Endangered species in various ecosystems, germplasm banks. Environmental impact assessment, bioremediation and biosafety. Introduction to national and international regulatory agencies, legislation and International treaties.

**Zoo. 101 Basic Zoology** **2+1 Sem. II**

Introduction to zoology. Structure and functions of cell and cell organelles. Difference between prokaryotic and eukaryotic cell. Cell division - mitosis and meiosis. Structure and function of biomolecules. Types of simple and compound tissues. Binomial nomenclature. Classification and general survey of animal kingdom. Functional organization of various systems of a mammal - digestive, circulatory, respiratory, excretory, nervous and reproductive. Laws of inheritance. Multiple allelism (blood groups). Genetic disorders in human and their inheritance.

**Practical** : Study of animal cell structure and cell division. Histological preparation of simple and compound tissues. General survey of animal kingdom up to phyla in invertebrates and up to classes in vertebrates. Demonstration of mammalian anatomy. Blood grouping.

**Zoo. 103 Elementary Human Physiology** **2+1 Sem. I**

Introduction to anatomy and physiology and structural organization of body. The cell -structure, its organelles, functions and multiplication, different types of cells and their functions. Movement of particles across cell membrane - active transport and passive transport. Body fluids and its compartments and functions. Water output and input into the body and maintenance of water balance in human body. The tissues - types, structure and their functions. The skeletal system - anatomy and functions, structure, formation and development of bones, different types of bones and types of joints and their movements. Circulatory system: the blood - composition and function, blood clotting and blood grouping, Heart - structure, functions, types of circulatory systems, blood pressure and heart rate and factors affecting it, electrocardiogram. The respiratory system: anatomy, functions, mechanism of breathing and respiratory volumes, gas transport and respiratory adaptation. The digestive system: anatomy and functions of alimentary tract and accessory organs, process of digestion of food, absorption and assimilation of digested food, enzymes involved in digestion of food, liver - structure and functions, pancreas - structure and functions. The urinary system: anatomy and functions, formation and composition of urine. The endocrine system: important ductless glands of the body and their functions. The reproductive system: male reproductive system – anatomy and functions, female reproductive system - anatomy and functions, menstrual cycle. The nervous system: elementary study of anatomy and functions. Sensory organs: anatomy and functions. Glossary of terms used in physiology.

**Practical** : Demonstration of animal viscera, identification of systems and organs, identification of cells - epithelial, muscle, nerve etc. Transverse section of stomach, intestine - small and large. Demonstration of specimens of spleen, kidney and brain. Models of excretory and reproductive organs and their histology. Colorimeter. Estimation of RBC count by hemocytometer. Estimation of WBC count by hemocytometer. Differential counting of WBC using peripheral smear. Estimation of PCV, ESR, micro and macro

heamatocrit. Estimation of bleeding and clotting time and blood groups. Measurement of pulse rate and blood pressure, its variation with exercise. Testing for sensation, special sensors, measurement of body temperature, diurnal variations.

**Zoo. 201 Introduction to Animal Biodiversity** **3+0** **Sem. I**

Description of biodiversity. General characteristics and outline of classification of different animal groups. Locomotion and reproduction in Protista. Skeletal and canal system in Porifera. Metagenesis, polymorphism, corals and coral reefs in Coelenterata. Parasitic adaptations and evolution of parasitism in Helminthes. Coelom, metamerism, excretion and polymorphism in Annelida. Vision, respiration and larval forms in Arthropods. Torsion and de-torsion, shell and respiration in Mollusca. Water vascular system and larval forms in Echinodermata. Salient features of Protochordates. Respiration, osmoregulation and migration in Fish. Respiration and parental care in Amphibia. Terrestrial adaptations and parental care in Reptiles. Respiration, flight and endothermy in Birds. Integument, dentition in Mammals and evolution of man.

**Zoo. 203 Introduction to Cell Biology and Immunology** **3+0** **Sem. II**

Cell structure, cell theories and cell division. Cell membrane and its models. Transport mechanisms and junctions. Cell organelles - mitochondria - structure and function. Racker's experiment. Nucleus - structure and functions, nuclear pore complex, nucleolus and its functions. Ribosomes, ER, Golgi apparatus, Microbodies, Lysosomes and Peroxisomes. Structure of cilia and flagella. Cell coat, cell-recognition and cell-cell interactions. Overview of immune system - innate and acquired immunity, generation of immunogenicity, recognition of antigens, properties of B-cell and T-cell epitopes, antigen-antibody interactions, immune effect or mechanisms, cytokines, complement system and hypersensitive reactions. Immune system in health and disease, vaccines, autoimmunity, AIDS and diagnostic tools.

**Zoo. 204 Introduction to Developmental Biology** **2+0** **Sem. I**

Introduction and scope of embryology. Gametogenesis, types of eggs, fertilization, parthenogenesis, cleavage, blastulation, gastrulation in Frog, Chick and Mammals, fate of germ layers and formation of extra-embryonic membranes in Chick. Human placenta (physiology and types). Embryonic induction - nature and action of organizer, tissue interactions and basis of induction. Differentiation. Post-embryonic morphogenesis. Larvae and their significance. Metamorphosis. Regeneration. Amniocentesis. Stem cell culture and cloning. Gene transfer into animal oocytes, embryos and tissues, biosafety and ethical issues of cloning. Growth. Ageing. Teratology - causes and examples.

**Zoo. 304 Fundamentals of Animal Physiology** **3+0** **Sem. I**

Compound tissues and types of glands. Heterotrophic forms of nutrition, transport and mixing of food in the alimentary canal, secretory functions of digestive tract, digestion, absorption and malfunctions of GIT. Pulmonary ventilation, physiological principle of gaseous exchange, transport of oxygen and $CO_2$ in the blood and regulation of respiration. Circulating body fluids and blood haemostasis. Heart as a pump, origin and propagation of heart beat, pulse, blood pressure, cardiac cycle and ECG. Functional anatomy of kidney, formation of urine, control of extracellular fluid, osmolality and counter-current mechanism, role of ADH and aldosterone. Physiology of human male and female reproduction. An over-view of other endocrine organs, their hormones and disorders. Functioning of excitable tissues, membrane potential, action potential and its propagation, synaptic and junctional transmission, ultra structure of the skeletal muscle fibre and molecular mechanism of muscle contraction. Physiology of sense organs and receptors.

**Zoo. 305 Fundamentals of Animal Ecology** **2+0** **Sem. II**

Scope and relevance of ecology. Factors of environment - atmosphere, soil, water, light and temperature. Liebig law of the minimum. Shelford law of tolerance. Ecotypes, isolation, evolution, speciation and indicator species. Interaction among organisms - competition, exploitation, predation, herbivory, parasitism and mutualism. Population regulation - abiotic factors, resource and interference competition, niche concept, community structure and dynamics, ecological succession, ecotones, structure and organization of ecosystems and flow of energy and nutrients. Nutrient replenishment. Biogeochemical cycles. Major ecosystems of the world - terrestrial, aquatic and agroecosystems. Zoogeography - barriers and means of dispersal. Bathymetric and geologic distribution. Endemism.

**Zoo. 306 Basic Experiments in Zoology** **0+3** **Sem. I**

**Practical** : General survey of Animal Kingdom - characteristics, classification, habits, habitat of important animal representatives of each phyla and classes and visit to Zoological Museum. Study of slides of cell and cell division. Demonstration of antigen-antibody reaction. Demonstration of viscera in Earthworm, Cockroach and model of Frog. Demonstration of activity of salivary amylase, respiratory gill movements in Fish, Bleeding and clotting time of blood, and sperm parameters in Rat. Slides of gametogenesis and embryonic development in Frog and Chick. Study of aquatic, terrestrial and agroecosystems.

**Zoo. 307 Systematics and Evolution of Animals** **2+1** **Sem. I**

Introduction to systematic zoology and its importance. Systematics and phylogeny. Zoological nomenclature, classification and concept of modern trends in systematics. Origin of life, concept of evolution, different theories of evolution, evolution of land vertebrates and man. Adaptations.

**Practical:** Identification of animals using modern and conventional methods.

**Zoo. 308 Applied Zoology** **3+1** **Sem. II**

Useful animals and their products. Outlines of apiculture, sericulture, lac culture, edible and pearl oyster culture, pisciculture/aquaculture, poultry farming, dairy farming etc. Important human and veterinary parasites - Protozoan and Helminths. Life cycle and biology of Plasmodium, Trypanosoma, Leishmania, Ascaris, Wuchereria, Fasciola, Schistosoma and Taenia. Molecular, cellular and physiological basis of host parasite interactions. Arthropods and vectors of human diseases (mosquitoes, lice, flies and ticks). Mode of transmission of pathogens by vectors. Chemical, biological and environmental control of Arthropod vectors. Biology and control of chief insect pests of agricultural importance. Bird pests and their control. Life cycle, damage and control of rodent pests of agriculture.

**Practical :** Study/survey of economically important animals. Study of Protozoan, Helminth parasites and Arthropod vectors associated with human diseases. Study of vertebrate pests of agricultural crops and their control.

**Zoo. 309 Zootechniques** **1+1** **Sem. II**

Collection, maintenance, rearing, upkeep of animals in captivity, preservation (dry and wet techniques), classification, labelling etc. Ethical issues related to animal health and their use for zoological studies. Collection of tissues and fluids from animals. Routes of administration of test chemicals to animals. Preparation of reagents, fixatives, stains and tissue processing for histological preparations. Details of microtomy. Basic and selective staining methods. Frozen cryocut sections and principles of histo-chemistry. Principles of microscopy and its upkeep. Tissue processing for biochemical estimations.

**Practical :** Collection of small and large animals. Preservation of specimens for museum. Demonstration of injection routes and collection of fluids in albino rat. Sacrificing the animal and fixation of material and its processing for histological studies of selected organs of Rat. Section cutting, stretching, staining and mounting of sections and their microscopic study.

**Zoo. 310 Fundamentals of Animal Behaviour** **2+1** **Sem. I**

Definition of behaviour. Psychology versus ethology and contemporary animal behaviour. Basic concepts and models of classical ethology. Types of behaviour. Social behaviour. Migration and dispersal. Coevolution of prey-predator behaviour.

**Practical :** Study of chemotaxis, feeding preferences and behaviour using animal maze.

**Zoo. 311 Fundamentals of Applied Human Physiology** **3+0** **Sem. I**

Introduction to cell physiology and membrane transport mechanisms. Physiology of digestion, absorption and GIT movements. Mechanism of external and internal respiration, hypoxia, apnea, asthma and dyspnea. Composition and functions of blood and lymph. Blood grouping and its transfusion. Anaemia and Thalassemia. Circulation - cardiac output, blood pressure, pulse, ECG, hypertension and artheroseclerosis. Mechanism of urine formation and haemostasis, micturition, kidney failure and dialysis. Mechanism of muscle contraction and physiology of exercise and fatigue. Functional neuroanatomy - action potential, nerve impulse and reflexes. General sensory receptors and physiology of special senses vision, hearing,

equilibrium and their disorders. Hormonal functions of various endocrine glands and their disorders. Physiology of male and female reproduction, puberty, pregnancy, parturition, lactation and menopause.

**Zoo. 312 Immunology** **2+1** **Sem. I**

History and scope of immunology. Components of immune system - organs, tissues and cells, Immunoglobulin structure and functions. Molecular organization of immunoglobulins and classes of antibodies. Antibody diversity - antigens, haptens, antigens antibody interactions. Immuno-regulation and tolerance. Allergies and hypersensitive response. Immunodeficiency. Vaccines - live attenuated vaccines, killed vaccines, cell culture based vaccines, recombinant vaccines. Immunological techniques. Immunological application in plant science, monoclonal antibodies and their uses. Molecular diagnostics.

**Practical :** Preparation of buffers and reagents. Precipitation and agglutination test, HA, HI test. Immunoblotting, immunoelectrophoresis and fluorescent antibody test. Enzyme immunoassays including ELISA variants, Western blotting. Raising of antisera in laboratory animals. Collection and preservation of antisera - separation, filtration and aliquoting.

**Zoo. 313 Animal Biotechnology** **3+1** **Sem. I**

History of animal biotechnology. Basic techniques in animal cell culture. Introduction to embryo biotechnology - oocyte collection and maturation, sperm preparation and in vitro fertilization. Cryopreservation of oocyte, sperm and embryos. Embryo transfer technology. Breeds of livestock and their characteristics. Marker assisted breeding of livestock. Introduction to animal genomics - RFLP, RAPD, SSRs, QTL, SNP, STR, Mitochondrial DNA polymorphism. Rumen and its environment - Rumen microbes and manipulation of rumen microbes for better utilization of feed. Introduction to nutrigenomics-milk biome, manipulation of lactation by biotechnological tools. Application of biotechnology in meat and meat products. Genome and protein based diagnostics of important animal diseases - FMD, Brucellosis, PPR, Mastitis, Blue tongue, Newcastle disease.

**Practical :** Basic cell culture techniques - oocyte aspiration from ovaries, sperm preparation and in vitro fertilization. PCR based detection of animal pathogens, PCR-RFLP. Immunohistochemical localization of protein marker in tissues/cells - meat species identification by PCREDIT.

**Zoo. 401 Form, Structure and Function of Invertebrates** **3+1** **Sem. II**

General characteristics and outline of classification of different animal groups upto classes. Interrelationships amongst the major and minor invertebrate phyla. Functional anatomy and physiology of locomotion, digestion, respiration, circulation, excretion, neural and endocrine regulation, reproduction, sense organs and receptors of invertebrates. Larval forms and their evolutionary significance.

**Practical :** General survey of invertebrate forms. Study of histological preparations of organs representing different systems. Dissection of Earthworm, Cockroach and Pila to demonstrate various systems. Experiments to demonstrate the response of some invertebrates to photic, mechanical, thermal, chemical and electrical stimuli.

**Zoo. 402 Form, Structure and Function of Vertebrates** **2+1** **Sem. II**

General characteristics and outline of classification of different animal groups upto orders. Functional anatomy and physiology of muscular, digestive, respiratory, sensory, circulatory, excretory, nervous, endocrine and reproductive systems of vertebrates.

**Practical :** General survey of vertebrate forms. Demonstration of animal viscera. Study of histological preparations of organs representing different systems. Demonstration of heart beat of Frog. Demonstration of neuronal and muscular activity. Study of reproductive cyclicity in female rat.

**Zoo. 403 Cell Biology and Development in Animals** **2+1** **Sem. II**

A detailed account of structure and functions of cell and cell organelles. Cell cycle and its regulation. Cell membrane - its chemical structure and models. Membrane differentiation, junctions and transport mechanisms, Cell coat (glycocalyx) and cell recognition, cell-cell interactions, cell signalling and cell migration. Extracellular matrix of animal cell. Cytoskeletal organelles and their functions, cellular nitches, stem cells and properties of excitable cells- neurons and muscles. Cell differentiation. Cell death

(apoptosis) and cancer cells. Introduction to developmental biology. Mechanism of sex determination. Gametogenesis and fertilization. Embryonic development, cleavage patterns, blastulation, gastrulation movements in Frog, Chick and Man and fate of germ layers. Extraembryonic membranes and placenta (physiology and types). Cell differentiation and morphogenetic movements. Induction and regeneration. Genes in development. Growth. Gerontology - ageing, concept and model. Teratology and teratogens.

**Practical :** Study of structure of special cells. Gametogenesis in gonads. Study of cleavage, blastulation, gastrulation in Frog and Chick eggs and preparation of slides.

**Zoo. 404 Environmental Biology and Management** **2+1** **Sem. II**

Concepts and dynamics of ecosystem, components, food chain and energy flow, productivity and biogeochemical cycles. Types of ecosystems, population ecology and biological control. Community structure and organization. Environmental pollution. Sustainable development. Economic importance of microbes, plants and animals. Bioresource management and regional conservation strategies - examples with reference to India. Wildlife management - sanctuaries, parks and biosphere reserves in India. Endangered and threatened animal species in India, Red data book, germplasm banks. Environmental issues impact of urbanization and industrialization and its assessment, disaster management, bioremediation and biosafety. Policies, regulatory agencies and legislation.

**Practical :** Study of different climatic factors - temperature, relative humidity, wind velocity and light intensity. Estimation of physico-chemical characteristics of soil and water. Ecological adaptations of animals in different habitats. Population estimates of planktons. Visit to national parks/sanctuaries and waste management parks.

**Zoo. 405 Introduction to Fish and Fisheries** **2+1** **Sem. I**

Importance of fishery science. Capture and culture fisheries of India. Classification of fishes. Lacustrine and riverine fisheries of Punjab. Biology of some freshwater, brackish water and marine food fishes. Effects of dams and pollution on fish and fisheries. Inland fishing gears. Management and conservation of Inland fishery resources.

**Practical :** Collection, identification and classification of fishes of economic importance. Study of different types of nets and demonstration of fishing operation. Visit to field/fish market to analyse species composition, their size and sex ratio in a commercial catch. Assessment of fish stock.

**Zoo. 426 Applied Human Physiology** **3+0** **Sem. I**

Introduction to cell and organ physiology. Movement of molecules through cell and other biological membranes. Composition and functions of blood and lymph, blood clotting, blood groups, blood transfusion, anaemia, thalassemia, inflammation, organ transplant, hypersensitivity and immunodeficiency syndromes. Physiology of digestion, absorption, GIT movements and constipation. Respiration - control of ventilation, gaseous exchange and transport, hypoxia, apnea, asthma and dyspnea. Circulation - cardiac output, systemic blood pressure, pulse, ECG, hypertension and artherosclerosis. Excretion - mechanism of muscle contraction and physiology of exercise and fatigue. Functional neuroanatomy - nerve fibre, synapse, action potential, nerve impulse and reflexes. General sensory receptors. Special senses retina photochemistry of vision and its disorders, hearing and its impairment. Functions of hormones of pituitary gland, thyroid, parathyroid, adrenal cortex, pancreas and endocrine disorders. Physiology of male and female reproduction, puberty, pregnancy, lactation and menopause.

## Postgraduate Courses

**Zoo.-501 Functional Anatomy and Physiology of Animals** **3+1** **Sem. I**

**Unit I** Functional anatomy and physiology of digestive and respiratory systems of animals. Active transport across membrane. Nutrition, digestion and absorption. Respiration - its types, regulation, breathing mechanism, sites of gas exchange, respiratory pigments and their oxygen carrying capacity.

**Unit II** Functional anatomy and physiology of circulatory and excretory systems of animals. Circulation (open and closed), lymphatic systems, blood composition and functions. Excretion and osmoregulation.

**Unit III** Functional anatomy and physiology of reproductive and muscular systems of animals. Reproductive patterns in animals. Muscular contraction and electric organs. Bioluminescence.

**Unit IV** Functional anatomy and physiology of sensory, nervous and endocrine systems of animals. Major sense organs and receptors. Nerve conduction and neurotransmitters. Homeostasis (neural and hormonal). Stress physiology.

**Practical :** Study of endo- and exo-skeletal structures. Histology of different organs. Anatomy of Rat and invertebrate types. Demonstration of activity of digestive enzymes (Amylase, Protease, Lipase). Haematological tests - PCV, DLC, TLC and RBC count. Haemoglobin estimation. Demonstration of pneumostatic recording of respiratory movements. Experiments on $Q_{10}$ basal metabolic rate and osmosis.

**Zoo.-502 Cell and Developmental Biology** **2+1** **Sem. I**

**Unit I** Structure of prokaryotic and eukaryotic cells. Membrane structure and functions. Intracellular compartments, protein sorting, secretory and endocytic pathways. Cytoskeleton, Nucleus, Mitochondria and Chloroplast and its genetic organization.

**Unit II** Cell cycle, Cell-cell interactions and signal transduction. Structure and organization of chromatin, polytene & lampbrush chromosomes. Dosage compensation and sex determination. Sex-linked inheritance.

**Unit III** Gametogenesis. Molecular events during fertilization. Cleavage patterns and fate maps. Concepts of determination, competence and induction, totipotency and nuclear transfer experiments. Cell differentiation and differential gene activity.

**Unit IV** Morphogenetic determinants in egg cytoplasm and morphogenesis. Role of maternal contributions in early embryonic development. Genetic regulations in early embryonic development in Drosophila- Homeotic genes. Teratology. Transgenic mice and their medical implications.

**Practical :** Isolations, fractionation and study of various cell organelles. Demonstration of membrane permeability and transport properties. Permanent microscopic preparations of cell organelles. Estimation of cell size and number. Chromosomal preparations and banding techniques. Use of spectrophotometry and fluorescent microscopy. Study of gametogenesis, cleavage and gastrulation in mammals.

**Zoo.-503 Biosystematics and Biodiversity** **1+1** **Sem. II**

**Unit I** Biological nomenclature and theories of biological classification. Modern trends in systematic-structural, biochemical and molecular aspects. DNA fingerprinting and numerical taxonomy.

**Unit II** Biodiversity- characterization, magnitude and distribution emphasizing their role as bioindicators of habitat quality, generation, maintenance and loss. Economic value.

**Unit III** Human impact and biodiversity. Diversity and conservation of Punjab fauna. Conservation strategies. Role of NGOs in biodiversity conservation.

**Practical :** Identification of important animals using conventional taxonomic keys and modern molecular methods. Sampling, extraction methods and identification of soil fauna.

**Zoo.-504 Animal Ecology and Bioresource Management** **2+1** **Sem. I**

**Unit I** Interactions between animals and environment. Concept of habitat and niches. Flow of energy, food chain,food web and trophic levels, ecological pyramids and recycling of materials. Nitrogen, Phosphorus, Carbon and Sulfur cycles in nature.

**Unit II** Ecosystem dynamics, stability and complexity of ecosystems. Degradation of major terrestrial and aquatic ecosystems of the world. Biotic community and its dynamics. Biological rhythms. Population ecology and biological control.

**Unit III** Renewable and non-renewable energy sources and their conservation. Environmental impact assessment. Management of environment and sustainable development.

**Practical :** Population estimates by capture - marked - recapture, (multiple and single) census. Major abiotic environmental factors. Weather elements and their recording climatographs. Succession in aquatic ecosystem. Food spectrum.

**Zoo.-505 Animal Behaviour and Wildlife Management** **1+1 Sem. II**

**Unit I** Behavioural patterns and their regulation. Feeding, learning, social and sexual behaviours. Parental care. Biological rhythms. Mimicry, dispersal and migration.

**Unit II** Background and current status of wildlife management and conservation in India. Biographical notes on important wild animals. Habitat management. Captive wildlife and wildlife census.

**Unit III** Wildlife damage control and mitigating human wildlife conflict. Wildlife Protection Act and wildlife projects. Conservation- principles and strategies. Wildlife in relation to agriculture.

**Practical :** Demonstrations of fixed action patterns. Maze experiments on animal learning. Food preference. Behaviour of oestrous females. Nest building behaviour and mate choice in birds. Identification of wildlife species and preparation of inventory. Economic evaluation of wildlife areas. To study management practices. Visit to Zoo and Sanctuaries.

**Zoo.-506 Life History and Reproductive Strategies of Invertebrates** **2+1 Sem. II**

**Unit I** Life histories of major groups of invertebrates and selection mechanism of population regulation.

**Unit II** Reproductive patterns in invertebrates, asexual methods and their environmental regulation, sex differentiation and development of reproductive organs.

**Unit III** Oogenesis and spermatogenesis and their neuroendocrine regulation. Fertilization and egg production. Alternation of generations, metamorphosis and parthenogenesis.

**Practical :** Study of asexual reproduction, gametogenesis, gametes and accessory reproductive organs. Demonstration of neurosecretory cells in invertebrates.

**Zoo.-507 Comparative Vertebrate Endocrinology and Reproduction** **2+1 Sem. II**

**Unit I** Neuroendocrine regulation, structure, secretion and functions of endocrine glands. Mechanism of action of hormones.

**Unit II** Reproductive patterns and their evolution in vertebrates. Environmental regulation of reproductive cyclicity. Sex determination.

**Unit III** Hormonal regulation of gametogenesis and ovulation. Gamete maturation, fertilization, implantation, pregnancy, parturition, lactation, fertility and its regulation.

**Practical :** Study of different endocrine glands and reproductive organs. Demonstration of methods of hormone assay. Qualitative and quantitative study of steroid biosynthesis (key enzymes, lipids, cholesterol). Determination of sperm concentration and motility. Study of estrous cycle in Rat. Induction of sperm capacitation in vitro.

**Zoo.-508 Biology and Management of Birds** **2+1 Sem. I**

**Unit I** Origin and evolution of birds. General survey and zoogeography. Population dynamics. Skin, scales, feathers and moulting.

**Unit II** Adaptations for flight. Types and aerodynamics of flight. Feeding habits. Birds as biological indicators. Migration and homing.

**Unit III** Reproduction - courtship and mating habits, nests, eggs, incubation, brood parasitism. Brooding and care of young. Reproductive and behavioural manipulations for management of birds. Relationship with man - useful and harmful aspects. Management of birds with particular reference to agriculture.

**Practical :** Survey of birds of agricultural importance. Types of nests and nesting sites. Bird census. Population estimation parameters. Mapping of nesting/roosting sites. Capturing and marking methods. Nesting and perching provision. Estimation of damages by birds and demonstration of methods for their management.

**Zoo.-509 Biology and Management of Mammalian Pests** **2+1 Sem. II**

**Unit I** Mammalian Pests, their classification and status. Biotic and abiotic factors affecting population dynamics, demography patterns and r & k selection strategies. Morphological, physiological and behavioural adaptations.

**Unit II** Foraging strategies, habitat selection, social organization and mate selection. Principles of mammalian pest management, risk assessment, impact on environment, pest control legislation and policies.

**Unit III** Rodent pests of agricultural crops and stored products, their biology and habitat analysis. Population and damage assessment.

**Unit IV** Rodent pest management strategies - types of rodenticides and their mode of action, repellents/ antifeedants, fertility control using synthetic chemicals and plant products, immunocontraception, mechanical control, environmental control, biological control and use of synthetic pheromones and predatory cues. Integration of different pest management strategies.

**Practical :** Collection, identification and preservation of rodent pests, estimation of population by different methods, damage assessment methods in different crop fields, burrow structure and methods of control with special reference to agriculture.

**Zoo.-510 Parasitology** **2+1** **Sem. II**

**Unit I** Introduction to parasitology. Morphology and life cycles of Protozoan and Helminth parasites of economic importance including Zoo and wild animals.

**Unit II** Life cycle and control of Arthropod and Mollusc vectors. Diagnosis and control of parasitic infections. Immunity to parasites. Conventional and novel methods of control of Protozoan and Helminth parasites and vectors.

**Unit III** Effect of climate change on proliferation and transmission of parasites. In vitro culture of parasites

**Practical :** Methods of collection, preservation and identification of Protozoan and Helminth parasites and Arthropod vectors. Diagnosis of parasitic infections - conventional and immunological methods.

**Zoo.-511 Animal Biotechnology** **2+1** **Sem. I**

**Unit I** History and scope of biotechnology. Brief review of concepts and trends in cell, tissue and organ culture. Somatic cell hybridization, hybridoma technology, monoclonal antibody production and their application.

**Unit II** Introduction to immune system, cellular and humoral immune response, vaccines, methods of vaccine production and antigen-antibody based diagnostic assays.

**Unit III** Biotechnologies involved in induced breeding of animals including artificial insemination, superovulation, in vitro fertilization and embryo transfer. Gene mapping, gene cloning and gene transfer. Transgenesis and animal cloning.

**Unit IV** Application of biotechnology in agriculture, veterinary science, pharmaceutical industry, food industry, chemical industry and environment.

**Practical :** Preparation and sterilization of culture media. In vitro culturing of somatic cells. Basic techniques in hybridoma and monoclonal antibody production. Induction of superovulation and embryo collection in mice. Oocyte maturation and capacitation in vitro. In vitro fertilization.

**Zoo.-512 Freshwater Ecology** **2+1** **Sem. II**

**Unit I** Introduction to limnology. Kinds of inland aquatic habitats. Physical, chemical and biological limnology of lakes, reservoirs, wetlands, streams and irrigation canals.

**Unit II** Major communities of fresh water - plankton, nekton, neuston and benthos. Mineral cycles. Biodegradation in different aquatic ecosystems.

**Unit III** Biology of polluted waters. Impact assessment of exotics in inland waters. Lake and reservoir restoration.

**Practical :** Use of limnological instruments. Study of the animal communities inhabiting inland waters. Estimation of physico-chemical parameters of freshwaters. Estimation of chlorophyll in phytoplanktons.

**Zoo.-591 Seminar** **1+0**

**Zoo.-599 Master's Research** **0+30**

## Ph.D. courses

**Zoo.-601 Advances in Cell and Developmental Biology** **2+1** **Sem. II**

**Unit I** Determinants of cell shape and motility. Dynamic state of membranes- replacement and turnover. Membrane potential and action potentials. Membrane receptors and their dynamics.

**Unit II** Transport through clathrin-coated and uncoated vesicles. Interaction between cells and their environment. Cell signaling. Extracellular matrix. Gene organization and regulation. DNA damage and repair. Retroviruses and cellular oncogenes.

**Unit III** Biology of cells in culture and animal cell lines. Biosensors and bioprobes. Stem cell biology. Somatic cell cloning. Recent aspects of parthenogenesis and chimeras.

**Unit IV** Gamete differentiation and molecular mechanisms of fertilization, cleavage, differentiation, induction and morphogenesis. Discussion on current advancements.

**Practical :** Subcellular fractionation and structural details of various cell organelles, Membrane permeability processes, DNA damage studies in cells by comet assay, Squash technique of chromosomal banding, Mammalian cell culture and subculturing techniques, Somatic cell cloning method, Permanent slide preparation for metagenesis.

**Zoo.-602 Advances in Animal Ecology, Behaviour and Bioresource Management** **2+1** **Sem. II**

**Unit I** Energy flow through ecosystems. Biotic factors governing the population growth. Food web andenergy flow in wetlands. Diversity and stability in ecosystems and natural communities. Aquatic,terrestrial and atmospheric pollution. Eutrophication.

**Unit II** Genetic basis of behavioural patterns, conditioning and nature v/s nurture hypothesis. Mechanism of biological rhythmicity. Social organization, communication mechanisms and basis of cooperation and conflict in animals. Sexuality and mating, reproductive and maternal behaviour in animals. Foraging and refuging systems.

**Unit III** Predatory behaviour. Behavioural regulation of animal populations. Major bioresources of the world. Dwindling energy resources and alternatives. Productivity and conservation of resources. Modern concepts in bioresource management.

**Unit IV** Climate change and bioresource stability. Terrestrial-aquatic ecosystem equilibrium. Principles and applications of remote sensing, GIS and GPS in bioresource management. Role of biotechnology in management of biological resources.

**Practical :** Types of ecosystems, Abiotic factors of agro-ecosystem, Feeding behaviour of animals, Breeding behaviour of animals, Food spectrum and trophic levels in terrestrial ecosystem, Applications of animal census techniques, AI based population mapping. Applications of GIS and GPS in ecological studies.

**Zoo.-603 Advances in Animal Biotechnology** **2+0** **Sem. II**

**Unit I** Recent aspects of animal cell culturing techniques. Somatic cell hybridization. Cell lines. Commercial scale production of animal cells and their application for in-vitro testing.

**Unit II** Conventional and recombinant approaches to vaccine production, hybridoma technology. Immunodiagnostics. Biotechnological approaches to reproduction, super ovulation, IVF, embryo culture and embryo transfer.

**Unit III** In-situ and ex-situ preservation of germplasm. Cryopreservation of gametes and embryos, embryo sexing and micromanipulation. In-vitro testing of germplasm of foetus for genetic defects.

**Unit IV** Pregnancy diagnosis kits, antifertility vaccines, gene knock out technology and animal models for human genetic disorders. Transgenic animals and applications. Animal cloning. Conservation of endangered species. Stem cells and their applications, ethical and regulatory issues of stem cells.

**Zoo.-604 Advances in Biosystematics and Biodiversity** **2+0 Sem. II**

**Unit I** Evolutionary trends in taxonomy. Recent trends in biosystematics. Molecular basis of hereditary mutation. Mechanism of speciation. Application of biotechnological techniques.

**Unit II** Macro evolutionary trends- role of adaptations and incidental effect. Emerging views from comparative biology and geology.

**Unit III** Biodiversity at genetic, species, ecosystem and landscape levels. Remote sensing in conservation biology. Biotic response to climate change. Phenological changes in animals.

**Unit IV** Biodiversity depletion and biological invasion. Factors influencing biodiversity. Biodiversity protection laws, treaties and organization. Management of protected areas.

**Zoo.-605 Animal Genomics** **2+0 Sem. II**

**Unit I** Constituents of the genome, organelle genomes, genes, multigene families and conserved sequences. Coding and non-coding fractions of the genome.

**Unit II** Genome sequencing strategies and technologies, conventional approaches, software and informatics for sequencing. STS, EST, SNPs and sequencing length polymorphism. Genetic mapping and technologies - FISH.

**Unit III** Outlook of genome sequencing, cDNA projects and cDNA libraries. Expressed sequence tag (EST) - projects for gene identification. Image consortium. Unigene. Functional genomics- positional cloning, microarrays and GFP techniques.

**Unit IV** Functional analysis of entire genomes. Serial analysis of gene expression (SAGE). Genotypic and phenotypic sequencing in mouse. Genetic diseases and gene therapies.

**Zoo.-606 Advances in Reproductive Biology of Invertebrates** **2+0 Sem. I**

**Unit I** Evolutionary relationships in reproductive patterns in invertebrates. Asexual reproduction-budding, gemmulation, regeneration, autotomy, grafting, fragmentation and their molecular mechanisms.

**Unit II** Sexual dimorphism. Sexual reproduction– patterns of sexuality, gametogenesis and mechanism for the release of gametes. Hermaphroditism. Epitoky. Neuroendocrine control of reproduction. Gamete diversity.

**Unit III** Variations in mating. Patterns and molecular mechanisms of fertilization. Larval forms, their dispersal and significance in life-history of animals.

**Unit IV** Environmental cues and invertebrate reproduction. Effect of UV radiations, xenobiotics and environmental pollutants on reproduction of invertebrates.

**Zoo.-607 Advances in Reproductive Biology of Vertebrates** **2+0 Sem. I**

**Unit I** Sex determination and differentiation. Origin of germ cells. Structural and functional aspects of male and female reproductive tracts. Male accessory sex glands, their secretions and composition of the semen.

**Unit II** Neuroendocrine regulation of reproduction. Role of hypothalamic and extra-hypothalamic areas infertility regulation. Hormonal and cellular regulation of spermatogenesis and oogenesis in Amphibians, Reptiles, Birds and Mammals. Differentiation of the spermatozoan.

**Unit III** Cellular and molecular aspects of follicular development and its auto-, para- and endocrine regulation. Sperm and oocyte maturation. Mechanism of follicular rupture and release of ovum during ovulation. Post-ovulatory ovarian changes and luteal functions.

**Unit IV** Molecular aspects of fertilization and implantation in various vertebrates. Assisted reproductive techniques. Reproductive cloning, its ethics and application. Discussion on current advancements.

**Zoo.-608 Molecular Endocrinology** **2+0 Sem. I**

**Unit I** Chemical nature, biosynthesis and mechanism of action of hormones. Hormone receptors. Extra-hypothalamic areas. Hypothalamo-hypophyseal axis and its control over various endocrine glands.

**Unit II** Structural and functional aspects of gonads, thyroid, parathyroid, adrenal and other endocrine tissues and mechanisms of their aberrant growth.

**Unit III** Endocrine disorders related with fertility, basal metabolism, hypertension, gastrointestinal tract and renal functions. Role of hormones in homeostasis.

**Unit IV** Functions of prostaglandins, thromboxines and leukotrines. Multiple endocrine neoplasia and humoral manifestations of cancer. Biotechnological advances in endocrinology. Discussion on current advancements.

**Zoo.-609 Advances in Biology and Management of Birds** **2+0** **Sem. I**

**Unit I** Anatomical, physiological and behavioural adaptations in birds. Different feeding systems of birds, energy balance and thermoregulation.

**Unit II** Avian reproduction, nesting, egg laying and parental care. Social behaviour and territoriality. Principles underlying bird migration.

**Unit III** Bird conservation-local, regional and global issues. Regulation of population of birds, their community structure in different agro-ecosystems and functional role. Demography and energy/resource flow interactions with economic analysis of crop. Pest and pest predator interactions.

**Unit IV** Problems and economic losses due to birds. Management strategies of avian populations. Biological, cultural, mechanical and chemical methods for the control of bird pests of agriculture. Beneficial role of birds in agriculture and their manipulation in biocontrol of insect pests. Significance and management of bird predators.

**Zoo.-610 Advances in Mammalian Pest Management** **2+0** **Sem. I**

**Unit I** Principles of mammalian pest management, mammalian pests, classification of pests and their status, damages caused, risk assessment and impact on environment.

**Unit II** Pest control orders, legislation and policy. Pest population monitoring and estimation, radiotelemetry and global positioning.

**Unit III** Rodent pests of agricultural crops and stored products. Mammalian pest management strategies. Chemical control - pesticide laws and regulations, pesticide application and safety, toxicants, repellents, antifeedants and attractants. Types of rodenticides and their mode of action.

**Unit IV** Fertility control using steroids, chemicals and plant products and immunocontraception. Use of semiochemicals for population regulation. Mechanical control physical killing and trapping. Environmental control - cultural control and habitat manipulation. Biological control - parasites, pathogens, predators and genetically modified agents. Integrated pest management and transfer of mammalian control technology.

**Zoo.-611 Advances in Parasitology** **2+0** **Sem. II**

**Unit I** Advances in culture of protozoan and helminth parasites. Physiology and molecular biology of Protozoan and Helminth parasites.

**Unit II** Genetic control of parasites. Strategies for the control of parasitic infections -biological, chemical and immunological.

**Unit III** Role of Arthropod/Molluscan vectors in the transmission of diseases. Strategies for the control of vectors and vector- borne diseases.

**Unit IV** Chemotherapy and mechanism of anthelminthic resistance. Immune evasion strategies of parasites. Molecular basis of host-parasite interactions. Molecular techniques in diagnosis of parasite diseases. New generation vaccines of Protozoa. Problem and prospects of Helminth vaccines.

**Zoo.-612 Applied Freshwater Ecology** **2+0** **Sem. I**

**Unit I** Community structure and dynamics in lentic and lotic water bodies. Factors influencing community dynamics. Concept of community dynamics indices. Application of basic chemistry principles. Physical, chemical and biological complexes in freshwater ecosystems.

**Unit II** Processes controlling elemental cycling in freshwater ecosystems. Soil-water interactions. Availability of nutrients and productivity of aquatic ecosystems. Trophic dynamics in lakes, reservoirs and wetland ecosystems.

**Unit III** Horizontal and vertical migrations of plankton. Aquatic pollution. Common transport process of aquatic pollutants like sewage, pesticides, oils, metals, radioactive and biochemical and biomedical wastes etc. in the aquatic environment.

**Unit IV** Algal blooms and their management. Biodegradation of inland aquatic ecosystems. Current methods of lake and reservoir restoration. Concept and scope of microbial consortia in protection of aquatic environment.

**Zoo.-691 Seminar I** **1+0**

**Zoo.-692 Seminar II** **1+0**

**Zoo.-699 Ph.D Research** **0+75**

## COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUT OF 5-YEAR INTEGRATED M.Sc. (Hons.) PROGRAMME IN BIOCHEMISTRY (CORE COURSES)

| **DEFICIENCY COURSES** | | |
|---|---|---|
| **BASIC SCIENCES AND HUMANITIES** | | **Cr. Hrs. Th+Pr** |
| For PCM base: | | |
| Bio. 101 | Introduction to Biology | 3+0 |
| For PCB base: | | |
| Math. 107 | Fundamental Mathematics | 2+1 |
| **Regional Language** | | |
| For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level | | |
| Pbi. 101 | Basic Punjabi | 0+2 (NC) |
| For ICAR Nominees and Foreign Students | | |
| Pbi. Cul. 101 | Punjabi Culture | 2+0 (NC) |
| **REQUIRED COURSES** | | |
| **BASIC SCIENCES AND HUMANITIES** | | |
| Bio. 101/Math. 107 | Introduction to Biology/Fundamental Mathematics | 3+0/2+1 |
| Bot. 202 | Plant Morphology | 3+0 |
| Chem. 201 | Organic Chemistry | 3+0 |
| Eng. 101 | General English | 1+1 |
| Zoo. 201 | Introduction to Animal Biodiversity | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | Basic Punjabi/Punjabi Culture | 0+2/2+0 (NC) |
| Biochem. 203 | Structure and Function of Biomolecules | 3+0 |
| Bot. 203 | Systematic Botany | 3+0 |
| Chem. 203 | Physical and Inorganic Chemistry | 2+1 |
| Micro. 202 | Introduction to Microbiology | 3+0 |
| Zoo. 203 | Introduction to Cell Biology and Immunology | 3+0 |
| Biochem. 209 | Introduction to Intermediary Metabolism | 3+0 |
| Bot. 204 | Plant Histology | 2+0 |
| Bot. 205 | Botany of Economic Plants | 2+0 |
| Micro. 203 | Basic Bacteriology | 2+0 |
| Micro. 204 | Basic Mycology and Phycology | 3+0 |
| Zoo. 204 | Introduction to Developmental Biology | 2+0 |
| Zoo. 304 | Fundamentals of Animal Physiology | 3+0 |
| Biochem. 303/ | Introduction to Membrane Biochemistry | 3+0 |
| Bot. 307/ | Plant Biodiversity and Environment | 2+1 |
| Chem. 301/ | Fundamental Organic Chemistry | 3+0 |
| Micro. 307/ | Bacterial Genetics | 3+0 |
| Zoo. 310 (Optional) | Fundamentals of Animal Behaviour | 2+1 |
| Biochem. 206 | General Enzymology | 2+0 |
| Biochem. 302 | Basic Experiments in Biochemistry | 0+3 |
| Bot. 301 | Fundamentals of Plant Physiology | 3+0 |

| | | |
|---|---|---|
| Eng. 201 | Communication Skills and Personality Development | 1+1 |
| Micro. 205 | Basic Virology | 2+0 |
| Micro. 305 | Basic Experiments in Microbiology | 0+3 |
| Phys. 202 | Fundamentals of Biophysics | 2+1 |
| Stat. 201 | Elementary Statistics | 2+0 |
| Zoo. 305 | Fundamentals of Animal Ecology | 2+0 |
| Biochem. 301 | Introduction to Molecular Biochemistry | 3+0 |
| Biochem. 421 | Fundamentals of Biochemistry | 3+0 |
| Biochem. 425 | Fundamentals of Plant Biochemistry | 2+0 |
| Bot. 302 | Basic Experiments in Botany | 0+3 |
| Econ. 203 | Introduction to Economics and Project Evaluation | 2+0 |
| Mgt. 421 | Introduction to Management and Marketing | 2+0 |
| Micro. 304 | Introduction to Applied Microbiology | 3+0 |
| Zoo. 306 | Basic Experiments in Zoology | 0+3 |
| Edu. Tour | Educational Tour | 0+2 (NC) |
| Biochem. 424 | Experiments in Biochemistry | 0+3 |
| Biochem. 426 | Fundamentals of Animal Biochemistry | 3+0 |
| Biochem. 429 | Biochemical and Biophysical Techniques | 3+0 |
| Biochem. 430 | Fundamentals of Enzymology | 3+0 |
| Biochem. 431 | Fundamentals of Membrane Biochemistry | 2+0 |
| Biochem. 432 | Clinical biochemistry | 2+1 |
| | | 106+3 (optional)+ 4(NC)=113 |

**AGRICULTURE**

| | | | |
|---|---|---|---|
| 1 | PBG 102 | Fundamental of Genetics | 2+1 |
| 2 | Biotech. 103 | Introduction to Biotechnology | 2+1 |
| 3 | Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| | | | 8 |

**AGRICULTURE ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1 | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1+0 |

**NSS/NSO/NCC**

| | | | |
|---|---|---|---|
| 1 | NSS/NSO/NCC | (SEM-I) | 0+1 (NC) |
| 2 | NSS/NSO/NCC | (SEM-II) | 0+1 (NC) |
| 3 | NSS/NSO/NCC | (SEM-III) | 0+1 (NC) |
| 4 | NSS/NSO/NCC | (SEM-IV) | 0+1 (NC)<br>4 (NC) |
| | | Total | 121+8 (NC) = 129 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

**SEMESTER-WISE PROGRAMME FOR 5-YEAR INTEGRATED M.Sc. (Hons.) IN BIOCHEMISTRY**

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| Bio. 101/Math. 107 | 3+0/2+1 | | Biochem. 203 | 3+0 |
| Bot. 202 | 3+0 | | Biotech. 103 | 2+1 |
| Chem. 201 | 3+0 | | Bot. 203 | 3+0 |
| Eng. 101 | 1+1 | | Chem. 203 | 2+1 |
| HDFS 106 | 1+0 | | CSE 101 | 1+2 |
| PBG 102 | 2+1 | | Micro. 202 | 3+0 |
| Zoo. 201 | 3+0 | | Zoo. 203 | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | 0+2/2+0 (NC) | | | |
| NSS/NSO/NCC | 0+1 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| Total | 18+3 (NC)=21 | | Total | 21+1(NC)=22 |
| **SECOND YEAR** | | | | |
| **SEM III** | | | **SEM IV** | |
| Biochem. 209 | 3+0 | | Biochem. 206 | 2+0 |
| Bot. 204 | 2+0 | | Biochem. 302 | 0+3 |
| Bot. 205 | 2+0 | | Bot. 301 | 3+0 |
| Env. 101 | 2+0 | | Eng. 201 | 1+1 |
| Micro. 203 | 2+0 | | Micro. 205 | 2+0 |
| Micro. 204 | 3+0 | | Micro. 305 | 0+3 |
| Zoo. 204 | 2+0 | | Phys. 202 | 2+1 |
| Zoo. 304 | 3+0 | | Stat. 201 | 2+0 |
| Biochem. 303/Bot. 307/ | 3+0/2+1 | | Zoo. 305 | 2+0 |
| Chem. 301/ Micro. 307/ | 3+0/3+0 | | | |
| Zoo. 310 (optional) | 2+1 | | | |
| NSS/NSO/NCC | 0+1 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| Total | 19+3(optional) +1(NC) = 23 | | Total | 22+1 (NC) = 23 |
| **THIRD YEAR** | | | | |
| **SEM V** | | | **SEM VI** | |
| Biochem. 301 | 3+0 | | Biochem. 424 | 0+3 |
| Biochem. 421 | 3+0 | | Biochem. 426 | 3+0 |
| Biochem. 425 | 2+0 | | Biochem. 429 | 3+0 |
| Bot. 302 | 0+3 | | Biochem. 430 | 3+0 |
| Econ. 203 | 2+0 | | Biochem. 431 | 2+0 |
| Mgt. 421 | 2+0 | | Biochem. 432 | 2+1 |
| Micro. 304 | 3+0 | | | |
| Zoo. 306 | 0+3 | | | |
| Edu. Tour | 0+2 (NC) | | | |
| | 21+2(NC) = 23 | | | 17 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUT OF 5-YEAR INTEGRATED M.Sc. (Hons.) PROGRAMME IN BOTANY (CORE COURSES)

| | | | |
|---|---|---|---|
| **DEFICIENCY COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | **Cr. Hrs. Th+Pr** |
| | For PCM base: | | |
| | Bio. 101 | Introduction to Biology | 3+0 |
| | For PCB base: | | |
| | Math. 107 | Fundamental Mathematics | 2+1 |
| **Regional Language** | | | |
| | For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level | | |
| | Pbi. 101 | Basic Punjabi | 0+2 (NC) |
| | For ICAR Nominees and Foreign Students | | |
| | Pbi. Cul. 101 | Punjabi Culture | 2+0 (NC) |
| **REQUIRED COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | |
| Bio. 101/Math. 107 | | Introduction to Biology/Fundamental Mathematics | 3+0/2+1 |
| Bot. 202 | | Plant Morphology | 3+0 |
| Chem. 201 | | Organic Chemistry | 3+0 |
| Eng. 101 | | General English | 1+1 |
| Zoo. 201 | | Introduction to Animal Biodiversity | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | | Basic Punjabi/Punjabi Culture | 0+2/2+0 (NC) |
| Biochem. 203 | | Structure and Function of Biomolecules | 3+0 |
| Bot. 203 | | Systematic Botany | 3+0 |
| Chem. 203 | | Physical and Inorganic Chemistry | 2+1 |
| Micro. 202 | | Introduction to Microbiology | 3+0 |
| Zoo. 203 | | Introduction to Cell Biology and Immunology | 3+0 |
| Biochem. 209 | | Introduction to Intermediary Metabolism | 3+0 |
| Bot. 204 | | Plant Histology | 2+0 |
| Bot. 205 | | Botany of Economic Plants | 2+0 |
| Micro. 203 | | Basic Bacteriology | 2+0 |
| Micro. 204 | | Basic Mycology and Phycology | 3+0 |
| Zoo. 204 | | Introduction to Developmental Biology | 2+0 |
| Zoo. 304 | | Fundamentals of Animal Physiology | 3+0 |
| Biochem. 303/ | | Introduction to Membrane Biochemistry | 3+0 |
| Bot. 307/ | | Plant Biodiversity and Environment | 2+1 |
| Chem. 301/ | | Fundamental Organic Chemistry | 3+0 |
| Micro. 307/ | | Bacterial Genetics | 3+0 |
| Zoo. 310 (Optional) | | Fundamentals of Animal Behaviour | 2+1 |
| Biochem. 206 | | General Enzymology | 2+0 |
| Biochem. 302 | | Basic Experiments in Biochemistry | 0+3 |
| Bot. 301 | | Fundamentals of Plant Physiology | 3+0 |

| | | |
|---|---|---|
| Eng. 201 | Communication Skills and Personality Development | 1+1 |
| Micro. 205 | Basic Virology | 2+0 |
| Micro. 305 | Basic Experiments in Microbiology | 0+3 |
| Phys. 202 | Fundamentals of Biophysics | 2+1 |
| Stat. 201 | Elementary Statistics | 2+0 |
| Zoo. 305 | Fundamentals of Animal Ecology | 2+0 |
| Biochem. 301 | Introduction to Molecular Biochemistry | 3+0 |
| Bot. 302 | Basic Experiments in Botany | 0+3 |
| Econ. 203 | Introduction to Economics and Project Evaluation | 2+0 |
| Mgt. 421 | Introduction to Management and Marketing | 2+0 |
| Micro. 304 | Introduction to Applied Microbiology | 3+0 |
| Zoo. 306 | Basic Experiments in Zoology | 0+3 |
| Edu. Tour | Educational Tour | 0+2 (NC) |
| Bot. 303 | Algae, Fungi and Lichens | 2+1 |
| Bot. 304 | Bryophyta | 2+1 |
| Bot. 305 | Pteridophyta | 2+1 |
| Bot. 306 | Gymnosperms | 2+1 |
| Bot. 401 | Plant Physiology-I (Plant Water Relations and Mineral Nutrition) | 2+1 |
| Bot. 402 | Plant Physiology-II (Plant Metabolism) | 2+1 |
| Bot. 403 | Plant Physiology-III (Growth, Differentiation and Morphogenesis) | 2+1 |
| | | 105+3 (optional)+ 4(NC) = 112 |

**AGRICULTURE**

| | | | |
|---|---|---|---|
| 1 | PBG 102 | Fundamental of Genetics | 2+1 |
| 2 | Biotech. 103 | Introduction to Biotechnology | 2+1 |
| 3 | Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| | | | 8 |

**AGRICULTURE ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1 | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1+0 |

**NSS/NSO/NCC**

| | | | |
|---|---|---|---|
| 1 | NSS/NSO/NCC | (SEM-I) | 0+1 (NC) |
| 2 | NSS/NSO/NCC | (SEM-II) | 0+1 (NC) |
| 3 | NSS/NSO/NCC | (SEM-III) | 0+1 (NC) |
| 4 | NSS/NSO/NCC | (SEM-IV) | 0+1 (NC)<br>4 (NC) |
| | | Total | 120+8 (NC) =128 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## SEMESTER-WISE PROGRAMME FOR 5-YEAR INTEGRATED M.Sc. (Hons.) IN BOTANY

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| Bio. 101/Math. 107 | 3+0/2+1 | | Biochem. 203 | 3+0 |
| Bot. 202 | 3+0 | | Biotech. 103 | 2+1 |
| Chem. 201 | 3+0 | | Bot. 203 | 3+0 |
| Eng. 101 | 1+1 | | Chem. 203 | 2+1 |
| HDFS 106 | 1+0 | | CSE 101 | 1+2 |
| PBG 102 | 2+1 | | Micro. 202 | 3+0 |
| Zoo. 201 | 3+0 | | Zoo. 203 | 3+0 |
| Pbi. 101/Pbi. Cul . 101 | 0+2/2+0 (NC) | | | |
| NSS/NSO/NCC | 0+1 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| Total | 18+3 (NC) = 21 | | Total | 21+1 (NC) = 22 |
| **SECOND YEAR** | | | | |
| **SEM III** | | | **SEM IV** | |
| Biochem. 209 | 3+0 | | Biochem. 206 | 2+0 |
| Bot. 204 | 2+0 | | Biochem. 302 | 0+3 |
| Bot. 205 | 2+0 | | Bot. 301 | 3+0 |
| Env. 101 | 2+0 | | Eng. 201 | 1+1 |
| Micro. 203 | 2+0 | | Micro. 205 | 2+0 |
| Micro. 204 | 3+0 | | Micro. 305 | 0+3 |
| Zoo. 204 | 2+0 | | Phys. 202 | 2+1 |
| Zoo. 304 | 3+0 | | Stat. 201 | 2+0 |
| Biochem. 303/Bot. 307/ | 3+0/2+1 | | Zoo. 305 | 2+0 |
| Chem. 301/ Micro. 307/ | 3+0/3+0 | | NSS/NSO/NCC | 0+1 (NC) |
| Zoo. 310 (optional) | 2+1 | | | |
| NSS/NSO/NCC | 0+1 (NC) | | | |
| Total | 19+3(optional) + 1(NC) = 23 | | Total | 22+1 (NC) = 23 |
| **THIRD YEAR** | | | | |
| **SEM V** | | | **SEM VI** | |
| Biochem. 301 | 3+0 | | Bot. 304 | 2+1 |
| Bot. 302 | 0+3 | | Bot. 305 | 2+1 |
| Bot. 303 | 2+1 | | Bot. 306 | 2+1 |
| Econ. 203 | 2+0 | | Bot. 401 | 2+1 |
| Mgt. 421 | 2+0 | | Bot. 402 | 2+1 |
| Micro. 304 | 3+0 | | Bot. 403 | 2+1 |
| Zoo. 306 | 0+3 | | | |
| Edu. Tour | 0+2 (NC) | | | |
| Total | 19 + 2 (NC) = 21 | | Total | 18 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUTOF 5-YEAR INTEGRATED M.Sc. (Hons.) PROGRAMME IN CHEMISTRY (CORE COURSES)

| **DEFICIENCY COURSES** | | |
|---|---|---|
| **BASIC SCIENCES AND HUMANITIES** | | **Cr. Hrs. Th+Pr** |
| For PCM base: | | |
| Bio. 101 | Introduction to Biology | 3+0 |
| For PCB base: | | |
| Math. 107 | Fundamental Mathematics | 2+1 |
| **Regional Language** | | |
| For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level | | |
| Pbi. 101 | Basic Punjabi | 0+2 (NC) |
| For ICAR Nominees and Foreign Students | | |
| Pbi. Cul. 101 | Punjabi Culture | 2+0 (NC) |
| **REQUIRED COURSES** | | |
| **BASIC SCIENCES AND HUMANITIES** | | |
| Bio. 101/Math. 107 | Introduction to Biology/Fundamental Mathematics | 3+0/2+1 |
| Bot. 202 | Plant Morphology | 3+0 |
| Chem. 201 | Organic Chemistry | 3+0 |
| Eng. 101 | General English | 1+1 |
| Zoo. 201 | Introduction to Animal Biodiversity | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | Basic Punjabi/Punjabi Culture | 0+2/2+0 (NC) |
| Biochem. 203 | Structure and Function of Biomolecules | 3+0 |
| Bot. 203 | Systematic Botany | 3+0 |
| Chem. 203 | Physical and Inorganic Chemistry | 2+1 |
| Micro. 202 | Introduction to Microbiology | 3+0 |
| Zoo. 203 | Introduction to Cell Biology and Immunology | 3+0 |
| Biochem. 209 | Introduction to Intermediary Metabolism | 3+0 |
| Bot. 205 | Botany of Economic Plants | 2+0 |
| Chem. 302 | Chemistry of agrochemicals, Plant Products and Growth Regulators | 1+1 |
| Micro. 203 | Basic Bacteriology | 2+0 |
| Micro. 204 | Basic Mycology and Phycology | 3+0 |
| Zoo. 204 | Introduction to Developmental Biology | 2+0 |
| Zoo. 304 | Fundamentals of Animal Physiology | 3+0 |
| Biochem. 303/ | Introduction to Membrane Biochemistry | 3+0 |
| Bot. 307/ | Plant Biodiversity and Environment | 2+1 |
| Chem. 301/ | Fundamental Organic Chemistry | 3+0 |
| Micro. 307/ | Bacterial Genetics | 3+0 |
| Zoo. 310 (Optional) | Fundamentals of Animal Behaviour | 2+1 |
| Biochem. 206 | General Enzymology | 2+0 |
| Biochem. 302 | Basic Experiments in Biochemistry | 0+3 |
| Bot. 301 | Fundamentals of Plant Physiology | 3+0 |
| Chem. 303 | Thermodynamics and Chemical Kinetics | 3+0 |

| | | |
|---|---|---|
| Chem. 304 | Basic Analytical Chemistry | 3+0 |
| Chem. 305 | Experiments in Inorganic Chemistry | 0+2 |
| Eng. 201 | Communication Skills and Personality Development | 1+1 |
| Phys. 202 | Fundamentals of Biophysics | 2+1 |
| Stat. 201 | Elementary Statistics | 2+0 |
| Biochem. 301 | Introduction to Molecular Biochemistry | 3+0 |
| Bot. 302 | Basic Experiments in Botany | 0+3 |
| Chem. 306 | Fundamental Inorganic Chemistry | 2+0 |
| Chem. 422 | Electrochemistry and Surface Chemistry | 3+0 |
| Econ. 203 | Introduction to Economics and Project Evaluation | 2+0 |
| Math. 207 | Biomathematics | 2+1 |
| Mgt. 421 | Introduction to Management and Marketing | 2+0 |
| Stat. 302 | Fundamental of Biostatistics | 2+1 |
| Edu. Tour | Educational Tour | 0+2 (NC) |
| Chem. 423 | General Organic Chemistry | 2+0 |
| Chem. 424 | Radioactivity and Transition Elements | 2+0 |
| Chem. 425 | Introduction to Metal Complexes and Chelates | 2+1 |
| Chem. 427 | Spectroscopy and Structure Elucidation | 2+0 |
| Chem. 428 | Experiment in Chemistry | 0+3 |
| Chem. 429 | Drugs, Biomolecules and Polymers | 3+0 |
| Chem. 430 | Fundamental Quantum and Solution Chemistry | 3+0 |
| | | 108+3 (optional)+ 4(NC) = 115 |

**AGRICULTURE**

| | | | |
|---|---|---|---|
| 1 | PBG 102 | Fundamental of Genetics | 2+1 |
| 2 | Biotech. 103 | Introduction to Biotechnology | 2+1 |
| 3 | Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| | | | 8 |

**AGRICULTURE ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1 | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1+0 |

**NSS/NSO/NCC**

| | | | | |
|---|---|---|---|---|
| 1 | NSS/NSO/NCC | (SEM-I) | | 0+1 (NC) |
| 2 | NSS/NSO/NCC | (SEM-II) | | 0+1 (NC) |
| 3 | NSS/NSO/NCC | (SEM-III) | | 0+1 (NC) |
| 4 | NSS/NSO/NCC | (SEM-IV) | | 0+1 (NC) |
| | | | | 4 (NC) |
| | | | Total | 123+8 (NC) =131 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## SEMESTER-WISE PROGRAMME FOR 5-YEAR INTEGRATED M.Sc. (Hons.) IN CHEMISTRY

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| Bio. 101/Math. 107 | 3+0/2+1 | | Biochem. 203 | 3+0 |
| Bot. 202 | 3+0 | | Biotech. 103 | 2+1 |
| Chem. 201 | 3+0 | | Bot. 203 | 3+0 |
| Eng. 101 | 1+1 | | Chem. 203 | 2+1 |
| HDFS 106 | 1+0 | | CSE 101 | 1+2 |
| PBG 102 | 2+1 | | Micro. 202 | 3+0 |
| Zoo. 201 | 3+0 | | Zoo. 203 | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | 0+2/2+0 (NC) | | | |
| NSS/NSO/NCC | 0+1 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| Total | 18+3 (NC)=21 | | Total | 21+1 (NC) = 22 |
| **SECOND YEAR** | | | | |
| **SEM III** | | | **SEM IV** | |
| Biochem. 209 | 3+0 | | Biochem. 206 | 2+0 |
| Bot. 205 | 2+0 | | Biochem. 302 | 0+3 |
| Chem. 302 | 1+1 | | Bot. 301 | 3+0 |
| Env. 101 | 2+0 | | Chem. 303 | 3+0 |
| Micro. 203 | 2+0 | | Chem. 304 | 3+0 |
| Micro. 204 | 3+0 | | Chem. 305 | 0+2 |
| Zoo. 204 | 2+0 | | Eng. 201 | 1+1 |
| Zoo. 304 | 3+0 | | Phys. 202 | 2+1 |
| Biochem. 303/Bot. 307/ | 3+0/2+1 | | Stat. 201 | 2+0 |
| Chem. 301/ Micro. 307/ | 3+0/3+0 | | NSS/NSO/NCC | 0+1 (NC) |
| Zoo. 310 (optional) | 2+1 | | | |
| NSS/NSO/NCC | 0+1 (NC) | | | |
| Total | 19+3(optional) + 1(NC) = 23 | | Total | 23+1 (NC) = 24 |
| **THIRD YEAR** | | | | |
| **SEM V** | | | **SEM VI** | |
| Biochem. 301 | 3+0 | | Chem. 423 | 2+0 |
| Bot. 302 | 0+3 | | Chem. 424 | 2+0 |
| Chem. 306 | 2+0 | | Chem. 425 | 2+1 |
| Chem. 422 | 3+0 | | Chem. 427 | 2+0 |
| Econ. 203 | 2+0 | | Chem. 428 | 0+3 |
| Math. 207 | 2+1 | | Chem. 429 | 3+0 |
| Mgt. 421 | 2+0 | | Chem. 430 | 3+0 |
| Stat. 302 | 2+1 | | | |
| Edu. Tour | 0+2 (NC) | | | |
| Total | 21+2 (NC) = 23 | | Total | 18 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUT OF 5-YEAR INTEGRATED M.Sc. (Hons) PROGRAMME IN MICROBIOLOGY (CORE COURSES)

| | | | |
|---|---|---|---|
| **DEFICIENCY COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | **Cr. Hrs. Th+Pr** |
| | For PCM base: | | |
| | Bio. 101 | Introduction to Biology | 3+0 |
| | For PCB base: | | |
| | Math. 107 | Fundamental Mathematics | 2+1 |
| **Regional Language** | | | |
| | For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level | | |
| | Pbi. 101 | Basic Punjabi | 0+2 (NC) |
| | For ICAR Nominees and Foreign Students | | |
| | Pbi. Cul. 101 | Punjabi Culture | 2+0 (NC) |
| **REQUIRED COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | |
| Bio. 101/Math. 107 | | Introduction to Biology/Fundamental Mathematics | 3+0/2+1 |
| Bot. 202 | | Plant Morphology | 3+0 |
| Chem. 201 | | Organic Chemistry | 3+0 |
| Eng. 101 | | General English | 1+1 |
| Zoo. 201 | | Introduction to Animal Biodiversity | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | | Basic Punjabi/Punjabi Culture | 0+2/2+0 (NC) |
| Biochem. 203 | | Structure and Function of Biomolecules | 3+0 |
| Bot. 203 | | Systematic Botany | 3+0 |
| Chem. 203 | | Physical and Inorganic Chemistry | 2+1 |
| Micro. 202 | | Introduction to Microbiology | 3+0 |
| Zoo. 203 | | Introduction to Cell Biology and Immunology | 3+0 |
| Biochem. 209 | | Introduction to Intermediary Metabolism | 3+0 |
| Bot. 204 | | Plant Histology | 2+0 |
| Bot. 205 | | Botany of Economic Plants | 2+0 |
| Micro. 203 | | Basic Bacteriology | 2+0 |
| Micro. 204 | | Basic Mycology and Phycology | 3+0 |
| Zoo. 204 | | Introduction to Developmental Biology | 2+0 |
| Zoo. 304 | | Fundamentals of Animal Physiology | 3+0 |
| Biochem. 303/ | | Introduction to Membrane Biochemistry | 3+0 |
| Bot. 307/ | | Plant Biodiversity and Environment | 2+1 |
| Chem. 301/ | | Fundamental Organic Chemistry | 3+0 |
| Micro. 307/ | | Bacterial Genetics | 3+0 |
| Zoo. 310 (Optional) | | Fundamentals of Animal Behaviour | 2+1 |
| Biochem. 206 | | General Enzymology | 2+0 |
| Biochem. 302 | | Basic Experiments in Biochemistry | 0+3 |

| | | |
|---|---|---|
| Bot. 301 | Fundamentals of Plant Physiology | 3+0 |
| Eng. 201 | Communication Skills and Personality Development | 1+1 |
| Micro. 205 | Basic Virology | 2+0 |
| Micro. 305 | Basic Experiments in Microbiology | 0+3 |
| Phys. 202 | Fundamentals of Biophysics | 2+1 |
| Stat. 201 | Elementary Statistics | 2+0 |
| Zoo. 305 | Fundamentals of Animal Ecology | 2+0 |
| Biochem. 301 | Introduction to Molecular Biochemistry | 3+0 |
| Bot. 302 | Basic Experiments in Botany | 0+3 |
| Econ. 203 | Introduction to Economics and Project Evaluation | 2+0 |
| Mgt. 421 | Introduction to Management and Marketing | 2+0 |
| Micro. 304 | Introduction to Applied Microbiology | 3+0 |
| Micro. 306 | Fundamentals of Food and Dairy Microbiology | 3+1 |
| Zoo. 306 | Basic Experiments in Zoology | 0+3 |
| Edu. Tour | Educational Tour | 0+2 (NC) |
| Micro. 303 | Introduction to Industrial Biotechnology | 2+1 |
| Micro. 401 | Practicals in Microbiology | 0+2 |
| Micro. 421 | Fundamentals of Microbiology | 2+1 |
| Micro. 426 | Fundamentals of Soil Microbiology | 2+1 |
| Micro. 427 | Fundamentals of Environmental Microbiology | 2+1 |
| Micro. 428 | Fundamentals of Clinical Microbiology | 2+1 |
| | | 105+3 (optional)+ 4(NC)=112 |

**AGRICULTURE**

| | | | |
|---|---|---|---|
| 1 | PBG 102 | Fundamental of Genetics | 2+1 |
| 2 | Biotech. 103 | Introduction to Biotechnology | 2+1 |
| 3 | Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| | | | 8 |

**AGRICULTURE ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1 | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1+0 |

**NSS/NSO/NCC**

| | | | |
|---|---|---|---|
| 1 | NSS/NSO/NCC | (SEM-I) | 0+1 (NC) |
| 2 | NSS/NSO/NCC | (SEM-II) | 0+1 (NC) |
| 3 | NSS/NSO/NCC | (SEM-III) | 0+1 (NC) |
| 4 | NSS/NSO/NCC | (SEM-IV) | 0+1 (NC)<br>4 (NC) |
| | | Total | 120+8(NC)=128 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## SEMESTER-WISE PROGRAMME FOR 5-YEAR INTEGRATED M.Sc. (Hons) in MICROBIOLOGY

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| Bio. 101/Math. 107 | 3+0/2+1 | | Biochem. 203 | 3+0 |
| Bot. 202 | 3+0 | | Biotech. 103 | 2+1 |
| Chem. 201 | 3+0 | | Bot. 203 | 3+0 |
| Eng. 101 | 1+1 | | Chem. 203 | 2+1 |
| HDFS 106 | 1+0 | | CSE 101 | 1+2 |
| PBG 102 | 2+1 | | Micro. 202 | 3+0 |
| Zoo. 201 | 3+0 | | Zoo. 203 | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | 0+2/2+0 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| NSS/NSO/NCC | 0+1 (NC) | | | |
| | | | | |
| Total | 18+3 (NC)=21 | | Total | 21+1 (NC) = 22 |
| **SECOND YEAR** | | | | |
| **SEM III** | | | **SEM IV** | |
| Biochem. 209 | 3+0 | | Biochem. 206 | 2+0 |
| Bot. 204 | 2+0 | | Biochem. 302 | 0+3 |
| Bot. 205 | 2+0 | | Bot. 301 | 3+0 |
| Env. 101 | 2+0 | | Eng. 201 | 1+1 |
| Micro. 203 | 2+0 | | Micro. 205 | 2+0 |
| Micro. 204 | 3+0 | | Micro. 305 | 0+3 |
| Zoo. 204 | 2+0 | | Phys. 202 | 2+1 |
| Zoo. 304 | 3+0 | | Stat. 201 | 2+0 |
| Biochem. 303/Bot. 307/ | 3+0/2+1 | | Zoo. 305 | 2+0 |
| Chem. 301/ Micro. 307/ | 3+0/3+0 | | NSS/NSO/NCC | 0+1 (NC) |
| Zoo. 310 (optional) | 2+1 | | | |
| NSS/NSO/NCC | 0+1 (NC) | | | |
| Total | 19+3(optional) + 1(NC)= 23 | | Total | 22+1 (NC) = 23 |
| **THIRD YEAR** | | | | |
| **SEM V** | | | **SEM VI** | |
| Biochem. 301 | 3+0 | | Micro. 303 | 2+1 |
| Bot. 302 | 0+3 | | Micro. 401 | 0+2 |
| Econ. 203 | 2+0 | | Micro. 421 | 2+1 |
| Mgt. 421 | 2+0 | | Micro. 426 | 2+1 |
| Micro. 304 | 3+0 | | Micro. 427 | 2+1 |
| Micro. 306 | 3+1 | | Micro. 428 | 2+1 |
| Zoo. 306 | 0+3 | | | |
| Edu. Tour | 0+2 (NC) | | | |
| Total | 20+2 (NC) = 22 | | Total | 17 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## COURSE CURRICULUM FOR 1st YEAR FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUT OF 5-YEAR INTEGRATED M.Sc. (Hons.) PROGRAMME IN PHYSICS (CORE COURSES)

| **DEFICIENCY COURSES** | | |
|---|---|---|
| **BASIC SCIENCES AND HUMANITIES** | | **Cr. Hrs. Th+Pr** |
| For PCM base: | | |
| Bio. 101 | Introduction to Biology | 3+0 |
| For PCB base: | | |
| Math. 107 | Fundamental Mathematics | 2+1 |
| Regional Language | | |
| For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level | | |
| Pbi. 101 | Basic Punjabi | 0+2 (NC) |
| For ICAR Nominees and Foreign Students | | |
| Pbi. Cul. 101 | Punjabi Culture | 2+0 (NC) |
| **REQUIRED COURSES** | | |
| **BASIC SCIENCES AND HUMANITIES** | | |
| Bio. 101/Math. 107 | Introduction to Biology/Fundamental Mathematics | 3+0/2+1 |
| Bot. 202 | Plant Morphology | 3+0 |
| Chem. 201 | Organic Chemistry | 3+0 |
| Eng. 101 | General English | 1+1 |
| Phys. 103 | Mechanics | 3+1 |
| Zoo. 201 | Introduction to Animal Biodiversity | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | Basic Punjabi/Punjabi Culture | 0+2/2+0 (NC) |
| Biochem. 203 | Structure and Function of Biomolecules | 3+0 |
| Chem. 203 | Physical and Inorganic Chemistry | 2+1 |
| Math. 105 | Calculus-I | 3+0 |
| Phys. 102 | Optics | 3+1 |
| Phys. 104 | Waves and Oscillations | 3+0 |
| Stat. 201 | Elementary Statistics | 2+0 |
| | | 36+2(NC)=38 |

**AGRICULTURE**

| | | | |
|---|---|---|---|
| 1 | PBG 102 | Fundamental of Genetics | 2+1 |
| 2 | Biotech. 103 | Introduction to Biotechnology | 2+1 |
| | | | 6 |

**AGRICULTURE ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1 | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |
| | | | 3 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1+0 |

**NSS/NSO/NCC**

| | | | |
|---|---|---|---|
| 1 | NSS/NSO/NCC | (SEM-I) | 0+1 (NC) |
| 2 | NSS/NSO/NCC | (SEM-II) | 0+1 (NC) |
| 3 | NSS/NSO/NCC | (SEM-III) | 0+1 (NC) |
| 4 | NSS/NSO/NCC | (SEM-IV) | 0+1 (NC)<br>4 (NC) |
| | | Total | 46+6 (NC) = 52 |

*The course curriculum for 2nd and 3rd year of the programme is yet to be approved.

## SEMESTER-WISE PROGRAMME FOR 5-YEAR INTEGRATED M.Sc. (Hons) in PHYSICS

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| Bio. 101/Math. 107 | 3+0/2+1 | | Biochem. 203 | 3+0 |
| Bot. 202 | 3+0 | | Biotech. 103 | 2+1 |
| Chem. 201 | 3+0 | | Chem. 203 | 2+1 |
| Eng. 101 | 1+1 | | CSE 101 | 1+2 |
| HDFS 106 | 1+0 | | Math. 105 | 3+0 |
| PBG 102 | 2+1 | | Phys. 102 | 3+1 |
| Phys. 103 | 3+1 | | Phys. 104 | 3+0 |
| Zoo. 201 | 3+0 | | Stat. 201 | 2+0 |
| Pbi. 101/Pbi. Cul. 101 | 0+2/2+0 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| NSS/NSO/NCC | 0+1 (NC) | | | |
| Total | 22+3 (NC) = 25 | | Total | 24+1 (NC) = 25 |

Note: i) Presently, the course curriculum for 1st year of the programme is approved.

ii) The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUTOF 5-YEAR INTEGRATED M.Sc. (Hons.) PROGRAMME IN ZOOLOGY (CORE COURSES)

| | | | |
|---|---|---|---|
| **DEFICIENCY COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | |
| | | | Cr. Hrs. Th+Pr |
| | For PCM base: | | |
| | Bio. 101 | Introduction to Biology | 3+0 |
| | For PCB base: | | |
| | Math. 107 | Fundamental Mathematics | 2+1 |
| **Regional Language** | | | |
| | For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level | | |
| | Pbi. 101 | Basic Punjabi | 0+2 (NC) |
| | For ICAR Nominees and Foreign Students | | |
| | Pbi. Cul. 101 | Punjabi Culture | 2+0 (NC) |
| **REQUIRED COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | |
| Bio. 101/Math. 107 | | Introduction to Biology/Fundamental Mathematics | 3+0/2+1 |
| Bot. 202 | | Plant Morphology | 3+0 |
| Chem. 201 | | Organic Chemistry | 3+0 |
| Eng. 101 | | General English | 1+1 |
| Zoo. 201 | | Introduction to Animal Biodiversity | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | | Basic Punjabi/Punjabi Culture | 0+2/2+0 (NC) |
| Biochem. 203 | | Structure and Function of Biomolecules | 3+0 |
| Bot. 203 | | Systematic Botany | 3+0 |
| Chem. 203 | | Physical and Inorganic Chemistry | 2+1 |
| Micro. 202 | | Introduction to Microbiology | 3+0 |
| Micro. 203 | | Basic Bacteriology | 2+0 |
| Zoo. 203 | | Introduction to Cell Biology and Immunology | 3+0 |
| Biochem. 209 | | Introduction to Intermediary Metabolism | 3+0 |
| Bot. 204 | | Plant Histology | 2+0 |
| Bot. 205 | | Botany of Economic Plants | 2+0 |
| Micro. 204 | | Basic Mycology and Phycology | 3+0 |
| Zoo. 204 | | Introduction to Developmental Biology | 2+0 |
| Zoo. 304 | | Fundamentals of Animal Physiology | 3+0 |
| Biochem. 303/ | | Introduction to Membrane Biochemistry | 3+0 |
| Bot. 307/ | | Plant Biodiversity and Environment | 2+1 |
| Chem. 301/ | | Fundamental Organic Chemistry | 3+0 |
| Micro. 307/ | | Bacterial Genetics | 3+0 |
| Zoo. 310 (Optional) | | Fundamentals of Animal Behaviour | 2+1 |
| Biochem. 206 | | General Enzymology | 2+0 |
| Biochem. 302 | | Basic Experiments in Biochemistry | 0+3 |

| | | |
|---|---|---|
| Bot. 301 | Fundamentals of Plant Physiology | 3+0 |
| Eng. 201 | Communication Skills and Personality Development | 1+1 |
| Micro. 205 | Basic Virology | 2+0 |
| Micro. 305 | Basic Experiments in Microbiology | 0+3 |
| Phys. 202 | Fundamentals of Biophysics | 2+1 |
| Stat. 201 | Elementary Statistics | 2+0 |
| Zoo. 305 | Fundamentals of Animal Ecology | 2+0 |
| Biochem. 301 | Introduction to Molecular Biochemistry | 3+0 |
| Bot. 302 | Basic Experiments in Botany | 0+3 |
| Econ. 203 | Introduction to Economics and Project Evaluation | 2+0 |
| Mgt. 421 | Introduction to Management and Marketing | 2+0 |
| Micro. 304 | Introduction to Applied Microbiology | 3+0 |
| Zoo. 306 | Basic Experiments in Zoology | 0+3 |
| Zoo. 307 | Systematics and Evolution of Animals | 2+1 |
| Edu. Tour | Educational Tour | 0+2 (NC) |
| Zoo. 308 | Applied Zoology | 3+1 |
| Zoo. 309 | Zoo techniques | 1+1 |
| Zoo. 401 | Form, Structure and Function of Invertebrates | 3+1 |
| Zoo. 402 | Form, Structure and Function of Vertebrates | 2+1 |
| Zoo. 403 | Cell Biology and Development in Animals | 2+1 |
| Zoo. 404 | Environmental Biology and Management | 2+1 |
| | | 106+3 (optional)+ 4(NC)=113 |

**AGRICULTURE**

| | | | |
|---|---|---|---|
| 1 | PBG 102 | Fundamental of Genetics | 2+1 |
| 2 | Biotech. 103 | Introduction to Biotechnology | 2+1 |
| 3 | Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| | | | 8 |

**AGRICULTURE ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1 | CSE 101 | Information and Communication Technology in Agriculture | 1+2 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1+0 |

**NSS/NSO/NCC**

| | | | | |
|---|---|---|---|---|
| 1 | NSS/NSO/NCC | (SEM-I) | | 0+1 (NC) |
| 2 | NSS/NSO/NCC | (SEM-II) | | 0+1 (NC) |
| 3 | NSS/NSO/NCC | (SEM-III) | | 0+1 (NC) |
| 4 | NSS/NSO/NCC | (SEM-IV) | | 0+1 (NC)<br>4 (NC) |
| | | Total | | 121+8 (NC) =129 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards.

## SEMESTER-WISE PROGRAMME FOR 5-YEAR INTEGRATED M.Sc. (Hons) in ZOOLOGY

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| Bio. 101/Math. 107 | 3+0/2+1 | | Biochem. 203 | 3+0 |
| Bot. 202 | 3+0 | | Biotech. 103 | 2+1 |
| Chem. 201 | 3+0 | | Bot. 203 | 3+0 |
| Eng. 101 | 1+1 | | Chem. 203 | 2+1 |
| HDFS 106 | 1+0 | | CSE 101 | 1+2 |
| PBG 102 | 2+1 | | Micro. 202 | 3+0 |
| Zoo. 201 | 3+0 | | Zoo. 203 | 3+0 |
| Pbi. 101/Pbi. Cul. 101 | 0+2/2+0 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| NSS/NSO/NCC | 0+1 (NC) | | | |
| Total | 18+3 (NC) = 21 | | Total | 21+1 (NC) = 22 |
| **SECOND YEAR** | | | | |
| **SEM III** | | | **SEM IV** | |
| Biochem. 209 | 3+0 | | Biochem. 206 | 2+0 |
| Bot. 204 | 2+0 | | Biochem. 302 | 0+3 |
| Bot. 205 | 2+0 | | Bot. 301 | 3+0 |
| Env. 101 | 2+0 | | Eng. 201 | 1+1 |
| Micro. 203 | 2+0 | | Micro. 205 | 2+0 |
| Micro. 204 | 3+0 | | Micro. 305 | 0+3 |
| Zoo. 204 | 2+0 | | Phys. 202 | 2+1 |
| Zoo. 304 | 3+0 | | Stat. 201 | 2+0 |
| Biochem. 303/Bot. 307/ | 3+0/2+1 | | Zoo. 305 | 2+0 |
| Chem. 301/Micro. 307/ | 3+0/3+0 | | NSS/NSO/NCC | 0+1 (NC) |
| Zoo. 310 (optional) | 2+1 | | | |
| NSS/NSO/NCC | 0+1 (NC) | | | |
| Total | 19+3(optional) + 1(NC)= 23 | | Total | 22+1 (NC) = 23 |
| **THIRD YEAR** | | | | |
| **SEM V** | | | **SEM VI** | |
| Biochem. 301 | 3+0 | | Zoo. 308 | 3+1 |
| Bot. 302 | 0+3 | | Zoo. 309 | 1+1 |
| Econ. 203 | 2+0 | | Zoo. 401 | 3+1 |
| Mgt. 421 | 2+0 | | Zoo. 402 | 2+1 |
| Micro. 304 | 3+0 | | Zoo. 403 | 2+1 |
| Zoo. 306 | 0+3 | | Zoo. 404 | 2+1 |
| Zoo. 307 | 2+1 | | | |
| Edu. Tour | 0+2 (NC) | | | |
| Total | 19+ 2 (NC) = 21 | | Total | 19 |

Note: The course curriculum for regular M.Sc. 2-year Programme approved by Academic Council will also be applicable to 5-Year Integrated M.Sc. (Hons.) Programme from 4th year onwards

## COURSE CURRICULUM FOR AWARD OF B.Sc. (Hons) AGRIBUSINESS MANAGEMENT
## 4 YEAR PROGRAMME (CORE COURSES)

| | | | |
|---|---|---|---|
| **DEFICIENCY COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | **Cr. Hrs. Th+Pr** |
| For PCM base: | | | |
| Bio. 102 | | Introductory Biology | 3+0 |
| For PCB base: | | | |
| Math. 103 | | Elementary Mathematics | 2+1 |
| **Regional Language** | | | |
| | For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level | | |
| | Pbi. 101 | Basic Punjabi | 0+2 (NC) |
| | For ICAR Nominees and Foreign Students | | |
| | Pbi. Cul. 101 | Punjabi Culture | 2+0 (NC) |
| **REQUIRED COURSES** | | | |
| **BASIC SCIENCES AND HUMANITIES** | | | |
| Bio. 102/Math. 103 | | Introductory Biology/Elementary Mathematics | 1+1/2+0 |
| Eng. 101 | | General English | 1+1 |
| Eng. 201 | | Communication Skills and Personality Development | 1+1 |
| Mgt. 101 | | Principles of Management and Organizational Behavior | 3+0 |
| Mgt. 102 | | Introduction to Financial Accounting | 2+1 |
| Soc. 103 | | Rural Sociology, Education Psychology and Constitution of India | 2+0 |
| Pbi. 101/Pbi. Cul. 101 | | Basic Punjabi/Punjabi Culture | 0+2/2+0 (NC) |
| Econ. 104 | | Introduction to Agricultural Economics | 2+0 |
| Mgt. 103 | | Business Environment and Ethics | 2+0 |
| Mgt. 104 | | Financial Management | 2+1 |
| Mgt. 105 | | Entrepreneurship Development in Agribusiness | 1+1 |
| Micro. 102 | | Elementary Microbiology | 2+1 |
| Econ. 206 | | Micro Economics and Macro Economics | 2+1 |
| Mgt. 205 | | Marketing Management | 2+0 |
| Stat. 207 | | Principles of Statistics | 2+1 |
| Econ. 207 | | Agricultural Finance and Insurance | 2+1 |
| ABM 201 | | Food Business Management | 2+0 |
| ABM 202 | | Value Chain and Retail Management in Agribusiness | 2+1 |
| ABM 203 | | Introduction to Commodity Markets | 2+1 |
| Econ. 208 | | International Trade and Policy in Agriculture | 2+0 |
| Econ. 209 | | Agricultural Price and Policy Analysis | 2+1 |
| Econ. 210 | | Theory and Practices of Banking | 2+0 |
| Stat. 208 | | Business Statistics | 2+1 |
| ABM 301 | | Agri-input Marketing Management | 1+1 |
| Econ. 305 | | Market Information and Intelligence | 2+1 |
| Mgt. 305 | | Managerial Accounting | 2+1 |
| Edu. Tour | | Educational Tour | 0+2 (NC) |

| | | |
|---|---|---|
| Econ. 304 | Farm Management, Production and Resource Economics | 1+1 |
| | Optional/ Elective Courses (Any Three ) | |
| Econ. 306 | Advances in Banking (Elective) | 2+1 |
| Soc. 301 | Gender Studies (Elective) | 2+1 |
| ABM 302 | Rural Marketing Management (Elective) | 2+1 |
| ABM 303 | Agribusiness Project Management (Elective) | 2+1 |
| Mgt. 306 | Strategic Business Management (Elective) | 2+1 |
| | Rural Awareness Work Experience (RAWE) | |
| RAWE-ABM 401 | Orientation | 0+2 |
| RAWE-ABM 402 | Village Attachment | 0+6 |
| RAWE-ABM 403 | Report Writing and Evaluation | 0+2 |
| ABM 404 | Agribusiness Student Project | 0+10 |
| | Experiential Learning on Agribusiness /Hands on Training/Skill Development | |
| ABM 405 | Entrepreneurship Development Programme | 0+2 |
| ABM 406 | Preparation of Business Plan | 0+4 |
| Econ. 492 | Market Intelligence Practices | 0+4 |
| ABM 407 | Internship /Industrial attachment | 0+10 |
| | | 64+9 (opional)+20 +20+4(NC)=117 |

**AGRICULTURE**

| | | | |
|---|---|---|---|
| 1 | Agron. 107 | Basic Agronomy and Production Technology for Kharif Crops | 1+1 |
| 2 | Env. 101 | Environmental Studies and Disaster Management | 2+0 |
| 3 | Agron. 202 | Production Technology for Rabi Crops | 1+1 |
| 4 | Biotech. 208 | Introduction to Plant Biotechnology for Agribusiness | 2+0 |
| 5 | PBG 103 | Introduction to Genetics and Plant Breeding | 1+1 |
| 6 | Pl. Path. 106 | Introduction to Plant Pathology | 1+1 |
| 7 | Soils. 106 | Soil and Water Management | 1+1 |
| 8 | Ent. 205 | Basic Entomology | 1+1 |
| 9 | AS 202 | Livestock, Poultry and Fish Production Management | 1+1 |
| 10 | FT 209 | Grading Standardization and Quality Management in Agri Food Products | 2+1 |
| 11 | Ext. 202 | Fundamentals of Agricultural Extension Education and Rural Development | 1+1 |
| 12 | Ent. 301 | Pests of Crops and Stored Grains and their Management | 2+1 |
| 13 | Pl. Path. 303 | Management of Post-harvest and Seed-borne Plant Diseases | 1+1 |
| 14 | Soils. 301 | Manures, Fertilizers and Soil Fertility Management | 2+1 |
| 15 | Agron. 306 | Sustainable Farming System and Precision Agriculture | 2+1 |
| 16 | Ent. 302 | Management of Beneficial Insects | 2+1 |
| 17 | Ext. 302 | Communication and Diffusion of Agricultural Innovations | 1+1 |
| 18 | PBG 303 | Intellectual Property Rights | 1+0 |
| 19 | PBG 306 | Principles and Practices of Seed Science and Technology | 1+1 |
| | | | 42 |

**AGRICULTURE ENGINEERING AND TECHNOLOGY**

| | | | |
|---|---|---|---|
| 1 | CSE. 102 | Basics of Computer Science and Bio-informatics in Agriculture | 1+2 |
| 2 | FMP 207 | Farm Machinery and Power for Managers | 1+1 |
| 3 | PFE 303 | Protected Cultivation and Secondary Agriculture | 1+1 |
| | | TOTAL: | 7 |

**COMMUNITY SCIENCE**

| | | | |
|---|---|---|---|
| 1 | HDFS 106 | Human Values | 1+0 |
| 2 | FN 306 | Food Science and Human Nutrition | 1+1 |
| | | | 3 |

**HORTICULTURE AND FORESTRY**

| | | | |
|---|---|---|---|
| 1 | Forst. 103 | Forest Resource Management | 1+1 |
| 2 | Hort. 207 | Post-harvest Physiology of Horticultural Produce | 2+1 |
| 3 | Veg. 202 | Production Technology for Vegetable and Spices | 1+1 |
| 4 | Flori. 202 | Production Technology for Ornamental Crops and Landscaping | 1+1 |
| 5 | Hort. 202 | Production Technology for Fruit and Plantation Crops | 1+1 |
| 6 | Hort. 301 | Post- harvest Management and Value addition of Fruits & Vegetables | 1+1 |
| | | | 13 |

**NSS/NSO/NCC**

| | | | | |
|---|---|---|---|---|
| 1 | NSS/NSO/NCC | (SEM-I) | | 0+1 (NC) |
| 2 | NSS/NSO/NCC | (SEM-II) | | 0+1 (NC) |
| 3 | NSS/NSO/NCC | (SEM-III) | | 0+1 (NC) |
| 4 | NSS/NSO/NCC | (SEM-IV) | | 0+1 (NC)<br>4 (NC) |
| | | Total | | 179+8 (NC) = 183 |

**SEMESTER VII. RAWE PROGRAMME**

- **Modulel**

**Rural Awareness Works Experience (RAWE) (0+10)**

**(1) RAWE-ABM 401** Orientation Programme (0+2)

**(2) RAWE-ABM 402** Village Attachment (0+6)

i. Exposure to the socio economic and cultural milieu
ii. Visit to the farmers' fields
iii. Collection of farm and agribusiness data and analysis
iv. Understanding farming practices
v. Study the support service linkages with institutional and non-institutional agencies
vi. Understanding agribusiness practices of farming community
vii. Exposure visit to Local Self-Governments, Rural Development Institutions, Co-operatives, Financial and Marketing Institutions and other parastatals.
viii. SWOC analysis and preparation of optimum Business Farm Plans.

**(3) RAWE-ABM 403** Report Writing and Evaluation (0+2)

- **Module ll**

**ABM 404** Agribusiness Student Project **(0+10)**

The students have to undertake a project work on organizational/managerial/institutional/ operational aspects related to Agri-business enterprises, Co-operative enterprises, financial and agri-marketing institutions and other related areas.

The Project Work has the following definite objectives:

a) To equip the students to identify and analyze the organizational, managerial and operational problems of various organizations involved in socio-economic development activities.

b) To train the students in the collection, classification, tabulation, analysis, presentation and interpretation of data and

c) To assist the students to acquire the report writing skills

The first two weeks, review of relevant literatures and identify the topic for project work in consultation with the project guide/teacher. Then the student shall make a presentation of the project proposal before an Evaluation Committee for approval. The presentation has to cover the statement of the problem, objectives, sampling design, techniques of data collection and analysis. After the project work is over the student has to submit the project report in the prescribed format. The committee constituted for the purpose will evaluate the work.

**SEMESTER VIII.** Experiential Learning on Agribusiness/Hands on Training/Skill Development

- **Module I**

**Experiential Learning on Agribusiness/ Hand on Training/ Skill Development (0+10)**

**i. ABM 405** Entrepreneurial Development Programme 0+**2**

**ii. ABM 406** Preparation of Business Plan. 0+**4**

**iii. Econ. 492** Market Intelligence Practices. 0+**4**

Report Writing, Presentation and Evaluation

**i. ABM 405** Entrepreneurial Development Programme 0+**2**

**ii. ABM 406** Preparation of Business Plan **(0+4)**

The students will prepare business plans for Agriculture and rural development businesses for Co-operatives/SHGs/Farmer Producer Companies/Local Self-governments/ State level Institutions /startups/otherexisting enterprises. The activities will encompass business environment scanning, assessment of financial, technical, social, environmental and economic sustainability and feasibility of the business plan, Network analysis and reporting in the standard format to suit the funding agencies.

iii. **Econ. 492** Market Intelligence Practices. 0+**4**

The students will be engaged in collection of data related to trends and patterns of market prices (spot and future prices) and structure, conduct & performance of wholesale markets, terminal markets, E-auction, E-NAM, the institutions involved in marketing of selected agricultural commodities and carryout market research. This exercise will sharpen the students' ability to carry out both empirical and fundament analysis for price discovery.

**Module II**

**ABM 407** Internship/Industrial attachment **(0+10)**

(i) Orientation

(ii) Internship / Industrial attachment in Agribusiness and allied enterprises /Regulated markets/Commodity Boards /Organized Retail Markets/Commercial Banks/ Regional Rural Banks/Co-operatives/ Producer Companies.

(iii) Report Writing and Evaluation

## SEMESTER-WISE PROGRAMME FOR
## B.Sc. (Hons) AGRIBUSINESS MANAGEMENT 4 YEAR PROGRAMME

| FIRST YEAR | | | | |
|---|---|---|---|---|
| **SEM I** | | | **SEM II** | |
| Agron. 107 | 1+1 | | Agron. 202 | 1+1 |
| Bio. 102/Math.103 | 1+1/2+0 | | Biotech. 208 | 2+0 |
| CSE 102 | 1+2 | | Econ. 104 | 2+0 |
| Eng. 101 | 1+1 | | Forst. 103 | 1+1 |
| Eng. 201 | 1+1 | | Mgt. 103 | 2+0 |
| Env. 101 | 2+0 | | Mgt. 104 | 2+1 |
| HDFS 106 | 1+0 | | Mgt. 105 | 1+1 |
| Mgt. 101 | 3+0 | | Micro. 102 | 2+1 |
| Mgt. 102 | 2+1 | | PBG 103 | 1+1 |
| Soc. 103 | 2+0 | | Pl. Path. 106 | 1+1 |
| Pbi. 101/Pbi Cul. 101 | 0+2 (NC)/2+0 (NC) | | Soils. 106 | 1+1 |
| NSS/NSO/NCC | 0+1 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| Total | 22+3 (NC) = 23 | | Total | 24+1 (NC) = 25 |
| **SECOND YEAR** | | | | |
| **SEM III** | | | **SEM IV** | |
| AS 202 | 1+1 | | ABM 201 | 2+0 |
| Econ. 206 | 2+1 | | ABM 202 | 2+1 |
| Econ. 207 | 2+1 | | ABM 203 | 2+1 |
| Ent. 205 | 1+1 | | Econ. 208 | 2+0 |
| FMP 207 | 1+1 | | Econ. 209 | 2+1 |
| FT 209 | 2+1 | | Econ. 210 | 2+0 |
| Hort. 207 | 2+1 | | Ext. 202 | 1+1 |
| Mgt. 205 | 2+0 | | Flori. 202 | 1+1 |
| Stat. 207 | 2+1 | | Hort.202 | 1+1 |
| Veg. 202 | 1+1 | | Stat. 208 | 2+1 |
| NSS/NSO/NCC | 0+1 (NC) | | NSS/NSO/NCC | 0+1 (NC) |
| Total | 25 + 1(NC)= 26 | | Total | 24+1 (NC) = 25 |
| **THIRD YEAR** | | | | |
| **SEM V** | | | **SEM VI** | |
| ABM 301 | 1+1 | | Agron. 306 | 2+1 |
| Econ. 305 | 2+1 | | Econ. 304 | 1+1 |
| Ent. 301 | 2+1 | | Ent. 302 | 2+1 |
| Hort. 301 | 1+1 | | Ext. 302 | 1+1 |
| Mgt. 305 | 2+1 | | FN 306 | 1+1 |
| PFE 303 | 1+1 | | PBG 303 | 1+0 |
| Pl. Path. 303 | 1+1 | | PBG 306 | 1+1 |
| Soils. 301 | 2+1 | | Optional/ Elective Courses (Any Three ) | |
| Edu. Tour | 0+2 (NC) | | ABM 302 | 2+1 |
| | | | ABM 303 | 2+1 |

| | | | | |
|---|---|---|---|---|
| | | | Econ. 306 | 2+1 |
| | | | Mgt. 306 | 2+1 |
| | | | Soc. 301 | 2+1 |
| Total | 20+ 2(NC) = 22 | | Total | 15+9=24 |
| **FOURTH YEAR** | | | | |
| **SEM VII (RAWE)** | | | **SEM VIII (ELP)** | |
| RAWE-ABM 401 | 0+2 | | ABM 405 | 0+2 |
| RAWE-ABM 402 | 0+6 | | ABM 406 | 0+4 |
| RAWE-ABM 403 | 0+2 | | Econ. 492 | 0+4 |
| ABM 404 | 0+10 | | ABM 407 | 0+10 |
| Total | 0+20 | | Total | 0+20 |

**ANNEXURE I**

**PUNJAB AGRICULTURAL UNIVERSITY**

**Programme of work for Postgraduate students**
to be submitted by HOD in quintuplicate

To

**The Dean**
**Postgraduate Studies**
**Punjab Agricultural University, Ludhiana**

The Advisory Committee of Mr/Ms **NAME OF STUDENT, CAPITAL, BOLD**

son/daughter of Sh._____ **IN CAPITAL, BOLD** & Sm _____ **IN CAPITAL, BOLD** Admission No. _____admitted in the Department of _____ **IN CAPITAL, BOLD**

in_____ **IN CAPITAL, BOLD** programme during the Academic Year_____ Semester 1/II, after consulting him/her in a meeting, makes the following statements and recommendations:

His/Her major field is: _____ **IN CAPITAL, BOLD** **As approved by AC PAU in the light of BSMA**

His/Her field of specialization is: ___ **IN CAPITAL, BOLD** **As approved by AC PAU in the light of BSMA**

His/her minor field is: _____ **IN CAPITAL, BOLD** **As approved by AC PAU in the light of BSMA**

**His/her academic qualifications prior to joining this programme are:**

| **Degree or Diploma** | **Year of passing** | **Division** | **Aggregate % age of marks or grade** | **Institution** | **Major subject(s)** |
|---|---|---|---|---|---|
| High School/ Senior Secondary School | | | | | |
| Bachelor degree Write Complete title of degree here | | | | | |
| Master degree Write Complete title of degree here | | | | | |
| Other (specify) | | | | | |

**Admission No.**_____ **Name of the Student**_____ IN CAPITAL, BOLD

**He/She has studied the following courses in major and minor fields in the Bachelor's programme**

| Title of the Course | Course No. | Credit Hours | Grade/OCPA obtained |
|---|---|---|---|
| | | | |
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| | | | |
| | | | |

*** He/She has studied the following courses in Major, Minor, Compulsory Common and Supporting Courses in the Master's programme**

| Title of the Course | Course No. | Credit Hours | Grade/OCPA obtained |
|---|---|---|---|
| | | | |
| | | | |
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| | | | |

* This information is to be furnished for Ph.D. students only.

**Admission No. _____ Name of the Student_____** IN CAPITAL, BOLD

**He/She shall be required to complete the following courses:**

| Classification of Courses | | Course No. | Title of Course | Credit Hours |
|---|---|---|---|---|
| **(i) Major** | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | 4 | | | |
| | 5 | | | |
| | 6 | | | |
| | 7 | | | |
| | 8 | | | |
| | | | **Total:** | |
| **(ii) Minor** | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | 4 | | | |
| | 5 | | | |
| | | | **Total:** | |
| **(iii) Supporting** | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | 4 | | | |
| | 5 | | | |
| | | | **Total:** | |
| **(iv) Common** | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | 4 | | | |
| | 5 | | | |
| | | | **Total:** | |
| **(v) Compulsory deficiency** | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | | | **Total:** | |
| **(vi) Deficiencies to be completed** | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | | | **Total:** | |
| | | | **Grand Total:** | |

Signature of the student: _____

**Admission No. _____ Name of the Student____** IN CAPITAL, BOLD -

## ADVISORY COMMITTEE

| S No. | Name | Designation & Department | Signature |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | (Nominee of Dean PGS) | | |

**Certified that:**

1. The courses shown under major, minor, supporting, common, compulsory deficiency and deficiency fields are according to the approved courses by the PAU in the light of BSMA.
2. The titles and credit hours shown against each course are correct according to the courses approved by the PAU in the light of BSMA.
3. The major and minor fields conform to those approved and mentioned under the new curriculum approved by the PAU in the light of BSMA.
4. The advisory committee is in accordance with the provisions of R.I.B.

_____ _____

(Major Advisor) (Head of the Department)

Forwarded in quintuplicate to the Dean, Postgraduate Studies, Punjab Agricultural University, Ludhiana.

Head

Department of_____

(Seal)

**For use in the office of Dean, Postgraduate Studies**

Approved/Not approved

Dean
Postgraduate Studies

CC:
Registrar, PAU
Head, Department of _____
(Three copies)

**Performa for Programme of Work can be downloaded from website www.pau.edu under Postgraduate Studies**

# ANNEXURE II
## PUNJAB AGRICULTURAL UNIVERSITY

### Proforma for addition/deletion of courses from the programme of work

To

The Dean Postgraduate
Studies
Punjab Agricultural University, Ludhiana

**Subject:** **Addition/Deletion of courses from the programme of work.**

The Advisory Committee of Mr/Ms_____

Admn No._____, Master's/Ph.D. student in its meeting held in the Department of_____on_____ has recommended the following changes in the programme of work.

Courses to be added

| Course No. | Course title | Credit hrs | Whether the course is major/supporting/minor | Reasons for change |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |

Courses to be deleted

| | | | | |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |

OCPA at the end of previous Semester _____

It is certified that the student has not obtained 'F' grade in the courses which are being deleted.

### ADVISORY COMMITTEE

| | Signature | Name in block letters |
|---|---|---|
| 1. | | (Major Advisor) |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |

Recommended and forwarded in duplicate to the Dean, Postgraduate Studies, PAU, Ludhiana.

Memo. No. _____
Dated_____

_____
Head of the Department

## ANNEXURE III
## PUNJAB AGRICULTURAL UNIVERSITY
## Proforma for submission of synopsis

Synopsis of Thesis/Dissertation Problem of Postgraduate Students : Master's degree/Ph.D.

Name of the student (Capital letters)_____Admission No. _____

Major Subject_____Minor Subject_____Major Advisor _____

1. **Title** _____
2. **Introduction** (highlighting knowledge gaps and objectives)
3. **Expected New Knowledge**
4. **Review of literature**
5. **Technical programme**

The details of each experiment should be given as under:

Experiment No. 1

i) Name of the experiment
ii) Location: Field/Lab
iii) Methodology
iv) Observations
v) Statistical analysis

Similar details of other experiment(s), if any, should be given.

6. **Schedule work - flow diagram**
7. **Collaboration with other Departments (if any)**

Name of the department

**Consent of the :**

**i)** Collaborating teacher_____ ii) Head of collaborating Department_____

**References**

_____

**Signature of the Student ADVISORY**

**COMMITTEE**

| | Name | Designation | Department | Signatures |
|---|---|---|---|---|
| Major Advisor | | | | |
| Member | | | | |
| Member | | | | |
| Member | | | | |
| Nominee of Dean PGS | | | | |

Forwarded five copies to the Dean, Postgraduate Studies, for approval of Synopsis Approval Committee.

Head of the Department_____

Dean, Postgraduate Studies

## ANNEXURE IV

### DEPARTMENT OF _____

### PUNJAB AGRICULTURAL UNIVERSITY, LUDHIANA

### Request for preliminary oral examination

This is to certify that Mr/Ms_____

Admn No._____of the Department of _____

has satisfactorily completed his/her written examination in the Major and Minor on_____

and_____respectively. Kindly arrange the preliminary oral examination. I recommend the list of following Six external examiners for the same:

1.
2.
3.
4.
5.

The advisory committee of the student consists of:

1.
2.
3.
4.
5.

Signature of Major Advisor

Name:

Official stamp

Recommended dates for the examination: From_____ to _____

Head of Department

Official stamp

Dean
Postgraduate Studies
PAU, Ludhiana

**NOTE:** This is to be sent in duplicate to the Dean, Postgraduate Studies, PAU, Ludhiana

## ANNEXURE V
## PUNJAB AGRICULTURAL UNIVERSITY

### Certificate of Preliminary Examination: Ph.D.

This is to certify that Mr/Ms _____

Admn No. _____ of the Department of _____

has been examined by us. The oral examination was held on _____

His/her performance in the examination has been found Satisfactory/Unsatisfactory.

| | |
|---|---|
| _____ | _____ |
| Major Advisor<br>(Name) | External Examiner<br>(Name and address) |
| _____ | _____ |
| Advisor | Advisor |
| _____ | _____ |
| Advisor | Advisor |

Forwarded (in duplicate) by the Head of the Department of _____
(Name of the Deptt.)
to the Dean, Postgraduate Studies, Punjab Agricultural University, Ludhiana.

Memo. No. _____ _____

Dated _____ Head of the Department

Forwarded by the Dean, Postgraduate Studies, to the Registrar, Punjab Agricultural University, Ludhiana for necessary action.

Memo. No. _____ _____

Dated _____ Dean, Postgraduate Studies

## ANNEXURE VI

### PUNJAB AGRICULTURAL UNIVERSITY

### Proforma for submission of the draft of the thesis/dissertation/project report

This is to certify that the draft of the thesis/dissertation/project report entitled*, "_____

_____

was submitted by Mr/Ms_____Admn No._____a Master's degree/Ph.D. student in the Department of _____

_____ for the comments and corrections. We will return this within ten days from the date of receipt.

### ADVISORY COMMITTEE

| Name | Signature with date | Department |
|---|---|---|
| 1. _____ (Major Advisor) | _____ | _____ |
| 2. _____ | _____ | _____ |
| 3. _____ | _____ | _____ |
| 4. _____ | _____ | _____ |
| 5. _____ | _____ | _____ |
| 6. _____ | _____ | _____ |

It is certified that the above mentioned student has completed all the course/research requirements for the award of Master/Ph.D. degree.

_____

Major Advisor

Recommended and forwarded to the Dean, Postgraduate Studies for taking further necessary action.

Head of the Department

Memo No. _____

Dated _____

* The title should be type written.

## ANNEXURE VII
## PUNJAB AGRICULTURAL UNIVERSITY

### Request for final oral examination of Master's/Ph.D. students

This is to certify that Mr/Ms_____

Admission No._____has completed all the courses/research requirements for the award of Master's/Ph.D. degree. A *list of Ten external examiners in respect of the student is recommended as under*:

1.

2.

3.

4.

5.

** The title of the thesis/project report /dissertation is as under:

_____

_____

_____

(Signature of Major Advisor)

Name

Office stamp

_____

Head of the Department

Office stamp

Recommended and forwarded by the Head of the Department to the Dean Postgraduate Studies, PAU, Ludhiana for further necessary action.

Note: Head of the Department may further add maximum up to two examiners if he/she so desires.

* Five examiners be listed for Master's degree and six examiners be listed for Doctorate degree

* *The Title of thesis/project report/dissertation & list of external examiners should be type written.

**ANNEXURE VIII**

## PUNJAB AGRICULTURAL UNIVERSITY

### Proforma for submission of Final Thesis/Dissertation/Project Report to Dean PGS

Name of the student _____ Programme : Master's degree/Ph.D.

Father's name _____ Admission No. _____

Major field _____

We, the members of the student's Advisory Committee, certify that we have read the thesis/dissertation/ project report and that suggestions made for improvement have been incorporated.

1. _____ 2. _____

3. _____ 4. _____

5. _____ 6. _____

Signature of the Major Advisor _____ Dated _____

Signature of the Head of Department _____ Dated _____

Forwarding thesis/dissertation/project report _____ Dated _____

Thesis/Dissertation/Project Report fee paid vide Receipt No. _____ Amount _____ dated _____

Nothing is due :
1. University Librarian
2. P.U. Extension Library
3. Concerned Dean (Book Bank)
4. Hostel Warden duly countersigned by the DSW
   (to be submitted at the time of viva-voce examination)

_____
Signature of Accounts Officer
with rubber stamp

Memo No. _____

Dated _____

_____
Head of the Department
with rubber stamp

The Dean, PGS
PAU, Ludhiana

This performa in duplicate should be submitted alongwith a copy of thesis for Master's degree & a copy of dissertation for Ph.D degree to the Head of the Department who will forward to Dean, Postgraduate Studies for approval before the last date for submission of thesis/dissertation/project report.

Date of receipt in the office of the Dean, PGS _____

Dean
Postgraduate Studies

# ANNEXURE IX
# PUNJAB AGRICULTURAL UNIVERSITY

**Certificate of Thesis/Dissertation/Project Report and Oral Examination for Master's/Ph.D. Programme**

This is to certify that the thesis/dissertation/project report entitled, _____ submitted by _____ (Admn. No._____) son/daughter of Shri_____ and Smt._____ to the Punjab Agricultural University in the partial fulfillment of the requirements of M.Sc./M.Tech./Ph.D. in the subject of _____ has been examined by us. His/her minor field is _____.

The candidate was examined orally by the committee on _____.

1. The Thesis/dissertation/project report has been found satisfactory (Yes/No)_____
2. Performance of the candidate in oral examination has been found satisfactory (Yes/No)_____
3. We recommend that the candidate should resubmit the thesis/dissertation/project report (Yes/No)_____
4. We recommend that the candidate should reappear for oral examination (Yes/No)_____
5. We recommend award of degree to the candidate (Yes/No)_____

**Advisory Committee**

1._____ _____
**(Major Advisor)** **External Examiner**
**(Name, designation and address)**

2._____
(Advisor)

3._____
(Advisor)

4._____
(Advisor)

5._____ _____
(Advisor) **(Nominee of Dean, PGS)**

Certified that all the necessary changes/corrections as suggested by the external examiner(s) and advisory committee have been incorporated in the thesis/dissertation/project report.

_____
Major Advisor

Verified

_____
Signature of the Head of the Department

Forwarded, (in duplicate) by Head of Department of _____of the College of _____ to the Dean, Postgraduate Studies.

**No.**
**Dated:**

_____
Signature of Head of the Dept.
With seal

**Forwarded by the Dean, Postgraduate Studies to the Registrar, for necessary action.**

No.
Dated

Signature of the Dean,
Postgraduate Studies

**Registrar, PAU**

## ANNEXURE X

**PUNJAB AGRICULTURAL UNIVERSITY**

## CERTIFICATE – I

This is to certify that the thesis/dissertation/project report entitled, "_____ _____" submitted for the degree of M.Sc./M.Tech./Ph.D., in the subject of _____(Minor subject:_____) of the Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by_____ under my supervision and that no part of this thesis/dissertation/project report has been submitted for any other degree.

This assistance and help received during the course of investigation have been **fully** acknowledged.

_____

(Major Advisor)

**ANNEXURE XI**

## CERTIFICATE – II

This is to certify that the thesis/dissertation/project report entitled, "_____ _____"submitted by_____(Admission No._____) to the Punjab Agricultural University, Ludhiana, in partial fulfillment of the requirements for the degree of M.Sc./M.Tech./Ph.D. in the subject of_____(Minor subject:_____) has been **approved by the Student's Advisory Committee alongwith** the External Examiner after an oral examination on the same.

_____ _____

(Major Advisor) (External Examiner)

_____

(Head of Department)

_____

Dean, Postgraduate Studies

**ANNEXURE XI**

**CONFIDENTIAL**

## Report of the Nominee of the Dean, Postgraduate Studies
## For Preliminary / Final Oral Examination

| | | |
|---|---|---|
| 1 | Name of the Student / Admission No. | |
| 2 | Name of the Department / School | |
| 3 | Place of Oral Examination<br>Date & Time of Preliminary / Final Oral Exam. | |
| 4 | Name & Address of External Examiner | |
| 5 | Name of the Major Advisor<br>Name(s) of the members of the Advisory Committee | |
| 6 | The Name(s) of the members of the Advisory Committee who could not attend the examination giving reasons. | |
| 7 | Did the Head of the Department attend the Oral Examination | |
| 8 | **General Remarks:**<br>a) Conduct of the Oral Exam.<br>b) Performance of the student | |

**(Signature)**
**Name & Designation of the Nominee of Dean PGS**