

SECTION VII

FACULTY OF AGRICULTURE

General Information

Disciplines

- Animal Science
- Agricultural Biotechnology
- Agricultural Meteorology
- Agronomy
- Entomology
- Extension Education
- Food Science and Technology
- Floriculture and Landscaping
- Forestry and Natural Resources
- Fruit Science
- Plant Breeding and Genetics
- Plant Pathology
- Nematology
- Soil Science
- Vegetable Science
- Course curriculum for B.Sc.Agri. (Hons.) 4 year Programme
- Course curriculum for B.Sc.Agri. (Hons.) 6 year Programme for first two years
- Course curriculum for B.Tech. Food Technology 4 year Programme
- Course curriculum for B.Sc. Biotechnology (Hons.) 4 year Programme
- Course curriculum for 2 year Certificate Course in Agriculture

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 Punjab 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 commissioners 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 (June 2001 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 (Sept. 2010 to February 2013). Since March 2013, Dr H S Dhaliwal is Dean of the College.

Before the establishment of PAU, the B.Sc. (Agri.) programme was organized on the old annual system of the Punjab 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 inservice Nepalese students was also started.

At the time of independence in 1947, some M.Sc. and one Ph.D. student who were earlier registered with the Punjab University, Lahore, continued their research for the fulfilment of their degree requirements as private candidates. The Punjab University 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 Agronomy (1963)
- Department of Animal Science (1963) [Shifted to GADVASU in 2006]
- Department of Entomology (1963)
- Department of Extension Education (1963)
- Department of Horticulture (1963) [Now department of Fruit Science]
- 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 Vegetable Crops, Landscaping and Floriculture (1974) [Now department of Vegetable Science]
- Department of Forestry and Natural Resources (1979)
- Department of Agrometeorology(1981) [Now School of Climate Change and Agricultural Meteorology (2012)]
- Department of Animal Nutrition and Forages (1991) [Shifted to GADVASU in 2006]
- Department of Seed Science and Technology (1991)
- Department of Floriculture and Landscaping (1994)
- School of Agricultural Biotechnology (2008)

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 were again dissolved in 2007 and all these Departments were demerged and created two schools for the efficient working. Thus, the college now has 13 departments and two Schools.

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 1976.

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 were 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. Agri. (Hons) 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. Agri. (Hons.) 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) have been implemented with effect from academic session 1998-99. At present, the recommendations of fourth Deans' Committee have also been implemented for all UG programmes with effect from academic session 2009-10.

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. Agri. (Hons) and B.Ed. programme, the college now offers M.Sc. programme in 14 disciplines and Ph.D. programmes in 12 disciplines. Keeping in view the sustainability of agricultural production in Punjab, new programmes at undergraduate and postgraduate level were initiated as B.Sc. Agri.(Hons.) 6-year programme after Matric (2008-09); B.Sc. Biotechnology (Hons.) 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 Certificate Course in Agriculture at Institute of Agriculture, Gurdaspur (2009-10); PG programmes started were M.Sc. Biotechnology (2008-09), Ph. D. Biotechnology (2009-10), Ph.D. Floriculture & Landscaping (2010-11) and recently M.Sc. Nematology (2011-12).

Realising 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 is a separate building named after Food Laureate, Dr G S Khush, with 18 laboratories for conducting research on plant tissue culture, plant transformation, molecular biology, molecular cytogenetics, genomics laboratories and temperature, humidity and light controlled facility apart from a fully functional Bioinformatics Centre. A Super Computer has recently been installed in the University for conducting research related to Computational Biology in Biotechnology. The School has collaborations and funding from the John Innes Centre, Norwich, UK., University of Nottingham, England; University of Tokyo, Japan; IRRI, Philippines; Ohio State University, USA ; University of Zurich, Switzerland; Texas A & M University, USA; Kansas State University, USA; University of Sydney, Australia and ICGEB, New Delhi.

Wheat genome sequencing project is a globally ambitious research programme in which 16 countries are involved under the umbrella of IWGSC (International Wheat Genome Sequencing Consortium). India has been entrusted with the responsibility of sequencing of Chromosome 2A, which is about 900 Mbp and is 2.5 times larger than the whole rice genome. Dept. of Biotechnology (DBT), Ministry of Science and Technology, Government of India funded this collaborative programme to the PAU, National Research Centre on Plant Biotechnology (NRCPB) New Delhi and University of Delhi South Campus (UDSC), New Delhi with a total budget of Rs 34 crore for a period of three years. PAU is the lead centre with a total budget of Rs 18 crore.

School of Climate Change and Agricultural Meteorology has recently been 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.

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 Spectroscopy (EDS), and Scanning Probe Microscope (SPM), Optical Upright Research Microscope, Ultracut Microtome and Cryo Attachment, and Ion Sputter Coater facilities. The latest high resolution imaging tools 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 facilitate 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 agriculture teaching. A book bank was started in the college out of funds contributed by students. The books are issued to students on loan 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 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.

ANIMAL SCIENCE

Undergraduate Courses

LPM 91 Animal Science-I **2+1** **Sem. I**

Importance, advantages and limiting factors in livestock, poultry and fish farming. Importance of milk, meat and egg in human food. Common terms and breeds/species of cattle, buffalo, sheep, goat, pig, poultry and fish. Breeding, housing, feeding and general management of different categories of livestock and poultry. Artificial Insemination, pregnancy diagnosis and detection of estrous in dairy animals. Scientific fish farming. Important diseases of livestock, poultry and fish along with their preventive measures.

Practical: Livestock: Visit to different livestock farms. External body parts of different livestock species. Restraining of different livestock species. Housing designs for different livestock species. Identification of feeds, fodders and computation of rations. Clean milk production. Record keeping. Poultry: Survey of university poultry farm. Study of body parts and differentiation of laying and non-laying birds. Housing designs and poultry equipments. Formulation of poultry rations. General management of poultry. Fisheries: Pond designs and their management. Identification and management of different types of fish.

LPM 205 Livestock Production and Management **2+1** **Sem. II**

Place of livestock in the national economy. Livestock development programmes of Govt. of India and State Govt. Important exotic and Indian breeds of cattle, buffalo, sheep, goat and swine. Measures and factors affecting fertility in livestock. Reproductive behaviour, estrous cycle, detection of estrous, Artificial Insemination (AI), pregnancy and parturition in various livestock species. Care of pregnant animal and new born young one. Physiology of milk secretion and different milking methods. Factors affecting milk yield and composition. Selection procedure and various systems of breeding in livestock. Feeding management of calves, heifers, pregnant and milch animals. Feeding and management of sheep, goat and swine. Housing principles for livestock. Vaccination and prevention of important diseases of livestock and poultry. Important breeds of poultry, egg formation, abnormal eggs and factors affecting egg size. Moulting, incubation, hatching and brooding. Housing, breeding, feeding and management of poultry. Biotechnological interventions in animal production and reproduction.

Practical: Visit to livestock farms and breed identification. Study of external body parts. Handling and restraining of animals. Judging of animals. Milking methods. Feeding and ration formulation. Record keeping. Study of reproductive organs and artificial insemination in cattle and buffaloes. Study of physiological norms. Hatching, housing and management of poultry. Economics of various livestock enterprises.

AGRICULTURAL BIOTECHNOLOGY

PROGRAMMES

1. **M.Sc. Biotechnology**
2. **Ph.D. Biotechnology**

COURSE REQUIREMENT

M.Sc.

Field of Specialization	Plant Tissue Culture and Transformation, Molecular Biotechnology
Required Courses	Biotech. 501, Biotech. 502, Biotech. 503, Biotech. 504, Biotech. 505
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem
Minor Fields	Plant Breeding & Genetics, Microbiology, Biochemistry, Botany, Plant Pathology, Entomology or any other as approved by Dean, Postgraduate Studies
Deficiency courses for students with elective other than Plant Breeding, Genetics and Biotechnology	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Plant Tissue Culture and Transformation, Molecular Biotechnology
Required Courses	Biotech. 601, Biotech. 602, Biotech. 603, Biotech. 604
Supporting Courses	Courses from subject matter fields (other than minor) relating to area of special interest and research problem
Minor Fields	Plant Breeding & Genetics, Microbiology, Biochemistry, Botany, Plant Pathology, Entomology or any other as approved by Dean, Postgraduate Studies
Deficiency Courses for students with M.Sc. (Agri.) in a discipline other than Biotechnology	Biotech. 501, Biotech. 502, Biotech. 503, Biotech. 504, Biotech. 505 and other courses as recommended by the Student's Advisory Committee.

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Biotech. 101 Introduction to Biotechnology	2+1	Sem. I
<p>Definitions of biotechnology. Agricultural biotechnology. Plant biotechnology. Microbial biotechnology. Animal biotechnology. Food biotechnology. Medical biotechnology. Environmental biotechnology. Industrial biotechnology. Marine biotechnology. Plant tissue culture. Somatic hybridization. Cytogenetics and molecular cytogenetics. Genetic transformation. Recombinant DNA technology. Gene cloning. Transgenic organisms. Molecular biology. Genomics. Proteomics. Bioinformatics. Nanobiotechnology.</p> <p>Practical: Orientation to biotechnology facility. Green house and screen house facility. Transgenic green houses. Utility and functioning of various kinds of equipments used in biotechnology research. Orientation to bioinformatics centre. Orientation to electron microscope facility.</p>		
Biotech. 102 Food Biotechnology	2+1	Sem. I
<p>(In collaboration with Department of Microbiology)</p> <p>Introduction to food biotechnology. Molecular genetics i.e. fundamentals of molecular biology with special reference to chemistry and biology and DNA structures. Biological role of DNA in cell metabolism. Genetic recombination mechanisms and technique used for improvement in microbial strains. Applications of genetical control mechanism in industrial fermentation process, (Induction, manipulation and recombination). Recombinant-DNA technology (plasmids and cloning) - cell and tissue culture. Continuous cultures. Secondary metabolites synthesis. Expression of foreign genes. Promoter (Enzyme). Biomass production by using various micro organisms. Application of biotechnology in food industry, pharmaceuticals and agriculture. Bio- gas plant, probiotics, prebiotics and GM foods.</p> <p>Practical: Micropropagation through tissue culture. Genetic engineering of plants. Strain improvement through U.V. mutation for lactose utilization. Chemical mutagenesis using chemical mutagens (Ethidium bromide). Determination of survival curves using physical and chemical mutagens. 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 etc. Agarose gel electrophoresis of plasmid DNA. Pesticide degradation by Pseudomonas spp.</p>		
Biotech. 301 Fundamentals of Recombinant DNA	3+1	Sem. II
<p>Emergence of Molecular Biology; DNA, RNA and protein synthesis; Recombinant DNA technology: Restriction endonucleases, cloning vectors, plasmids, cosmids, phagemids, BACs, PACs, YACs, MACs, Transposon vectors, Expression vectors, Shuttle vectors, Binary plant vectors, Cointegrating vectors; Strategies to develop vectors; Restriction enzymes, restriction cleavage, construction of chimeric DNA, Genetic transformation of E. coli and selections; applications of chimeric DNA; Basic techniques of agarose gel electrophoresis, Nucleic acid blotting, Southern blotting, Northern blotting, Western blotting, preparation of probes, PCR and gene amplification, DNA sequencing; Creating and screening of library.</p> <p>Practical: Orientation of recombinant DNA lab, preparation of stock solutions and buffers, plasmid DNA isolation, Genomic DNA isolation, restriction digestion of DNA, Agarose gel electrophoresis, PCR, genetic transformation of E. coli, Screening of recombinant DNA clones in E. coli.</p>		
Biotech. 302 Introduction to Plant Tissue Culture	2+1	Sem. I
<p>Concepts and history. Various aspects of plant tissue culture. Somatic cell cultures. Somatic embryogenesis. Meristem culture. In vitro grafting. Micropropagation. Somaclonal variation. Anther and pollen culture. Embryo/ovule/ovary culture. Protoplast culture and somatic hybridization. Production of secondary metabolites through tissue culture. Cryopreservation of germplasm.</p>		

Practical: Medium preparation. Surface sterilization of explants. Establishment of callus/cell suspension cultures. Induction of plant regeneration. Hardening and transfer to soil. Micropropagation. Embryo culture. Anther and pollen culture.

Biotech. 303 Introduction to Nanobiotechnology **2+0** **Sem. I**

Concepts and Terminology; Nano-Bio Interface; Biological based Nanosystems, molecular motors, biosensors and other devices; Self assembly of molecules for nanotechnology applications; Biomimetics, Biotemplating and de-novo designed nanostructures and materials; DNA-Nanotechnology; Nanobiotechnology use in bioanalytical technology; Nanomanipulations, material design and synthesis and their applications.

Biotech. 304/Micro. 303 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 shakers. Batch and continuous cultures. Use of fermentors. Raising somatic cell cultures. Hairy root cultures.

Biotech. 305 Introduction to Molecular Biology **2+0** **Sem. II**

Introductory module that provides a broad overview of molecular biology concepts relevant to the plant sciences. Structure and variation of prokaryotic and eukaryotic nuclear and organelle genomes, including changes in genome size. Plasmids - types, construction and use in molecular biology. Construction, maintenance and uses of genomic and cDNA libraries. Polymerase chain reaction - principle and applications. Molecular markers- their development and use in genetic and physical mapping and molecular breeding. Positional gene cloning, genomic sequencing and comparative genomics.

Biotech. 306 Introduction to Molecular Genetics **2+0** **Sem. II**

Structure and properties of DNA. Molecular mechanisms of DNA replication, repair, mutation, and recombination. Centromere/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. Small RNAs, RNA interference and its applications. Genome evolution and molecular phylogenetics. Epigenetic control of gene expression.

Biotech. 307 Introduction to Bioinformatics **2+1** **Sem. II**

Introduction to Bioinformatics. Importance of Bioinformatics. Applications of computers in bioinformatics research. Mapping and sequencing. Sequencing DNA, RNA and Proteins. PCR primer designing. Protein structure, classification and analysis. Informal retrieval- Sequence alignment and similarity searches- BLAST, FASTA, data submission. Bioinformatic resources-NCBI, EBI, ExPASy, EMBL, GENBANK, Entrez, DDBJ, PDB, SWISSPORT, TREMBL, PIR_PSD. Phylogenetics analysis. Genome projects. Computational Biology.

Practical: Sequence information resource- Understanding and using on web- EMBL, GENBANK, Entrez, unigene. Protein information resource -understanding and using on web- PDB, SWISSPORT, TeEMBL. Using BLAST and interpreting results. Multiple sequence alignment using ClustalW.

Biotech.308 Instrumentation in Biotechnology **0+2** **Sem. II**

Light microscopes, Stereo microscopes, Phase contrast microscopes, Inverted microscopes, Scanning electron microscopes, Tunneling electron microscopes, Atomic force microscopes. Thermal cyclers, PCR, Tetrad, Realtime. Table top centrifuges, Refrigerated centrifuges, Ultra centrifuges. Chromatography, HPLC, FPLC. Immunoassays, ELISA readers. Analytical sensors, pH, oxidative reduction potential. Mass spectrophotometer, ICP spectrophotometer. DNA extractor, DNA synthesizer, DNA sequencer. Gel electrophoresis, 2-D gel electrophoresis, Pulse field gel electrophoresis, Power supplies, Gel

documentation, Gel driers. NMR. Freeze driers/lyophilizers. Temperature control shakers, BOD shakers. Gene pulser, Particle gun. Plant growth chambers.

Biotech. 309 Introduction to Cell Biology **2+ 1** **Sem. II**

Origin and evolution of cell; Cells as experimental model; Functional organization of a cell; Structure and composition of the plasma membrane, cell wall and extracellular matrix; Cytoskeleton and cellular interactions; Water relations and ion transport mechanisms; Endomembrane system- endoplasmic reticulum, Golgi apparatus and lysosomes; Bioenergetics and metabolism- mitochondria, chloroplast and peroxisomes; Cell cycle and cell signaling mechanisms; The nucleus- nuclear envelope, organization of nucleolus and chromatin, genomes, DNA and flow of genetic information; Mutations; Cell death and cell renewal.

Practical: Fractionation of cell contents by differential centrifugation; isolation and purification of rough and smooth reticulum, Golgi stacks and mitochondria; Membrane permeability and transport properties; Preparation of materials for microscopic studies; Procedures for counting and distinguishing live and dead cells; Cell culture techniques.

Biotech. 310 Principles of Plant Biotechnology **2+1** **Sem. I**

Concepts. History of Plant Tissue Culture and Plant Genetic Engineering. Scope and importance in crop improvement. Nutritional requirements of in-vitro cultures. Micro propagation. Anther culture. Pollen culture. Ovule culture. Embryo culture. Test tube fertilization. Endosperm culture. Somaclonal variation. Somatic embryogenesis and synthetic seed production technology. Protoplast isolation, culture, manipulation and fusion. Products of somatic hybrids and cybrids- applications in crop improvement. Genetic engineering. Restriction enzymes. Vectors for gene transfer. Gene cloning. Direct and indirect method of gene transfer. Transgenic plants and their applications. Blotting techniques. DNA finger printing. DNA based markers - RFLP, AFLP, RAPD, SSRs SNPs. DNA Probes. QTL Mapping. MAS and its application in crop improvement.

Practical: Requirements for Plant Tissue Culture Laboratory. Techniques in Plant Tissue Culture. Media components and preparations. Sterilization techniques and Inoculation of various explants. Aseptic manipulation of various explants. Callus induction and Plant Regeneration. Micro propagation of important crops. Anther, Embryo and Endosperm culture. Hardening / Acclimatization of regenerated plants. Somatic embryogenesis and synthetic seed production. Isolation of protoplast. Demonstration of Culturing of protoplast. Demonstration of isolation of DNA. Demonstration of gene transfer techniques- direct methods. Demonstration of gene transfer techniques- indirect methods. Demonstration of confirmation of genetic transformation. Demonstration of gel-electrophoresis techniques.

Undergraduate Elective/M.Sc. supporting/Minor Courses

Biotech. 311 Introduction to Plant Tissue Culture and Genetic Transformation **2+1** **Sem. I**

Concepts and history. Various aspects of plant tissue culture. Somatic cell cultures. Somatic embryogenesis. Meristem culture. *In vitro* grafting. Micropropagation. Somaclonal variation. Anther and pollen culture. Embryo/ovule/ovary culture. Protoplast culture and somatic hybridization. Production of secondary metabolites through tissue culture. Cryopreservation of germplasm. Methods of Genetic Transformation, commercialization of transgenic crops.

Practical: Medium preparation. Surface sterilization of explants. Establishment of callus/cell suspension cultures. Induction of plant regeneration. Hardening and transfer to soil. Micropropagation. Embryo culture. Anther and pollen culture. Particle Gun Bombardment

Biotech. 312 Introduction to Molecular Biotechnology **2+1** **Sem. II**

Genome organization of prokaryotes and eukaryotes; Restriction endonucleases- classification, properties and uses in molecular biology; Recombinant DNA technology; Construction and uses of genomic and cDNA libraries; Southern, Northern and Western Hybridization; RFLPs; Polymerase Chain Reaction and its variants; PCR based markers like RAPDs, SSRs, AFLPs, SNPs and their variants; uses of molecular markers in generation of molecular linkage maps, gene mapping and marker assisted breeding; DNA sequencing; gene cloning approaches.

Practical: Preparation of competent cells and Transformation. Isolation and purification of and fractionation of plant DNA. Agarose and PAGE Gel electrophoresis. Measurement of nucleic acids concentration using photospectrometer and gel electrophoresis. DNA amplification using RAPD primers and its fractionation in agarose gel. DNA amplification using microsatellite primers and its fractionation using polyacrylamide gels. Estimation of genetic similarities and generation of dendrograms using NTSYS/DARwin software. Introduction to various databases.

Biotech. 313 Environmental Biotechnology **2+0** **Sem. II**

Bioremediation; GMOs for bioremediation. Phytoremediation. Strategies for detection and control of soil, air and water pollutants. Bioreactors, bioaugmentation. Biotechnological interventions for enhancing bioefficacy of bioagents; mode and mechanism of action. Generation of alternate fuels in plants using gene over-expression/knock down strategies. Identification and manipulation of micro-organisms for biodegradation of plastics and polymers. Industrial applications of environmental biotechnology. Biosafety, social and ethical considerations of environmental issues, solutions using biotechnology.

Biotech. 401 Introduction to Genomics and Proteomics **3+0** **Sem. I**

Genomic analysis tools: large scale DNA sequencing, genetic mapping, micro-array technologies, robotics, and bioinformatics. Structure of genomes: bacteria, yeast, nematode, Arabidopsis, rice, zebra fish, mouse and man. High-resolution genetic analysis: genetic markers (SSR, AFLP and SNP's), mapping methods (family analysis, bulked segregant analysis, identity by descent, whole genome association) and positional gene identification. Transcript profiling: EST sequencing, SAGE, cDNA fragment analysis methods, array-based hybridization approaches. Gene characterization: covers DNA sequence analysis, assessment of gene expression, functional genomics approaches, and production of transgenic plants. Genomics approaches for improvement of biotic stresses, abiotic stresses and quality characteristics in crop plants. Analysis and characterization of proteins and metabolites: Introduction to transcriptomics, proteomics and metabolomics; proteomics approaches to the analysis of plant proteins, protein-protein interactions, and metabolic profiling through emerging metabolomic techniques like 2D gel electrophoresis and Mass spectrometric and computational techniques.

Biotech. 402 Fundamentals of Cytogenetics & Molecular Cytogenetics **2+1** **Sem. I**

Introduction and history. Structure of chromatin. Chromosome structure and Chromosome landmarks. Mitosis, Meiosis and chromosomal karyotypes. Specialized chromosomes. Changes in chromosome number-aneuploidy, haploidy and polyploidy. Structural aberrations of chromosomes-deletions, duplications, inversions, translocations. Differential staining of the chromosomes- Q-banding, G banding, C banding, R banding, In situ hybridization-FISH, GISH, BAC-FISH, Fibre-FISH. Locating genes on chromosomes. Practical: Microscopy. Microphotography. Preparation of chromosome stains. Pollen fertility. Preparation of mitotic and meiotic slides of onion, bajra and wheat. C-banding of the chromosomes. Preparation of karyotypes. Genomic in situ hybridization.

Biotech. 403 Techniques in Molecular Biology-I **0+2** **Sem. I**

Preparation of competent cells and Transformation. Isolation and purification of plasmid DNA. Isolation, purification and fractionation of plant DNA. Gel electrophoresis: Theoretical background. Measurement of nucleic acids concentration using photospectrometer and gel electrophoresis. DNA amplification using RAPD primers and its fractionation in agarose gel. DNA amplification using microsatellite primers and its fractionation using polyacrylamide gels. DNA amplification using AFLP primers and fractionation of AFLPs. Southern transfer and nucleic acids hybridization using radio active technique. DNA sequencing. Introduction to various databases. Primer designing from genes and other genomic sequence. Generation of linkage maps and mapping of qualitative genes mapmaker. Estimation of genetic similarities and generation of dendrograms.

Biotech. 404 Computational Biology **3+1** **Sem. I.**

Bioinformatics and metabolic engineering. Introduction to databases on the web, LIGAND. Enzyme databases: BRENDA, A primer on enzyme nomenclature. Searching and analyzing enzyme data, Metacyc. Single nucleotide polymorphisms (SNPs); SNP detection methods: SSCP, PCR based, DGGE, TGGE, dHPLC sequencing. SNP and disease. Polymorphism versus Mutations. SNP database – dbSNP. SSR

identification. Proteomics automation and analysis. Mass spectroscopy to characterize proteins and protein complexes. Protein-protein interaction databases, genome-wide protein interaction studies, protein interaction databases. Phylogenetic profiles. Gene neighbourhood. Gene fusion, strings database. Ensembl, NCSC genome browser, VISTA, NCBI genome. Problems of complexity, repeats and size. Principles of protein structure prediction, fold recognition. Analysis of membrane proteins, hydropathy plots.

Practical: Genome Browsers. Microarray databases. Protein-protein interaction databases. Protein structural classification databases. Molecular pathway databases. SNP and SSR identification tools.

Biotech. 406 Functional Genomics **2+0** **Sem. I**

Prokaryotic and eukaryotic gene structure, function and regulation. RNA modifications; splicing, RNA processing, RNA interference and functional genomics. Functional genomics tools; gene knockouts, random and site directed mutagenesis, transposon mutagenesis, gene knock down and gene therapy. Epigenetics; DNA methylation, histone modifications, chromatin remodeling. Microarray technologies and applications in functional genomics. Gene expression analysis. Comparative genomic hybridization. Transcriptome sequencing approaches for functional genomics. Applications of functional genomics for crop improvement.

Biotech. 433 Principles and Procedures of Plant Tissue Culture and Transformation **2+1** **Sem. I**

Concepts of plant tissue culture and transformation. Various aspects of plant tissue culture. GMO's / LMO's/ transgenics. Gene transfer methods. Agrobacterium mediated plant transformation. Particle gun mediated plant transformation. Molecular characterization of transgenic plants using PCR, Southern and Western analysis. Bioassays with transgenic plants. Genetic engineering of crop plants for useful traits. Foods for the future. Biosafety concerns and regulatory mechanisms. Commercialization of transgenic products.

Practical: Establishment of direct and indirect in vitro plant regeneration methods for genetic transformation. Gene constructs and their maintenance. Agrobacterium mediated genetic transformation. Particle mediated genetic transformation. Histochemical GUS assays. PCR screening of putative transgenic plants. Raising transgenic plants under contained conditions.

Biotech. 434 Principles and Procedures of Molecular Biotechnology and Genomics **2+1** **Sem. I**

Classification, properties and uses of restriction endonucleases. Characteristics and uses of plasmids in molecular biology. Recombinant DNA technology. Construction and uses of genomic and cDNA libraries. Genome organization of prokaryotes and eukaryotes. Southern, Northern and Western hybridization. RFLPs. Polymerase chain reaction. PCR-based markers like RAPDs, SSRs, ISSRs, STS, Scars. Generation of molecular maps. Applications of biotechnology in crop improvement. DNA sequencing. Gene cloning approaches. Functional genomics, proteomics and bioinformatics.

Practical: Isolation, purification and fractionation of DNA and proteins. Isolation and purification of plasmids. Measurement of protein and nucleic acid concentration using photospectrometer. DNA amplification using RAPD/SSR primers and its fractionation in agarose gel. Generation of linkage maps and mapping of qualitative genes using important web sites on computer.

Biotech. 499 In-house Project Training **0+20** **Sem. II**

After the completion of the course work, the B.Sc. Biotechnology (Hons.) students would undergo compulsory In-house Project Training on various aspects of Biotechnology for the duration of one semester. The students will submit plan of work to the class teacher(s) within two weeks of joining and detailed project report two weeks prior to the end of the semester. The evaluation of the In-house Training will be based on the project report submitted and oral presentation cum viva voce.

Postgraduate Courses

Biotech. 501 Plant Tissue Culture and Genetic Transformation **2+1** **Sem. I**

Plant cell and tissue culture its importance and history. Culture media for callus, suspension, nurse, root, meristem, etc. In vitro differentiation. Plant growth regulators. Molecular basis of plant organ differentiation. Various aspects of plant tissue culture micropropagation, anther and microspore culture, somaclonal variation, embryo rescue, wide hybridization, in vitro mutagenesis, in vitro fertilization and in vitro germplasm

conservation. Production of secondary metabolites. Synthetic seeds. Protoplast culture and regeneration. Somatic hybridization: protoplast fusion etc. Vector and vector less methods of plant transformation. Genetic and molecular analyses of transgenics. Target traits and transgenic crops. Biosafety issues of transgenics, regulatory procedures for commercial approval.

Practical: Setting up a tissue culture and transformation laboratory. Preparation of nutrient media. Handling and sterilization of plant material. Inoculation, subculturing and plant regeneration. Anther and pollen culture. Embryo rescue. Suspension cultures and production of secondary metabolites. Protoplast isolation, culture and fusion. Gene cloning and vector construction. Gene transfer using vector and vectorless methods, reporter gene expression, selection of transformed tissues/plants, molecular analysis.

Biotech. 502 Principles of Biotechnology **2+0** **Sem. II**

History, scope and importance of recombinant DNA. Recombinant DNA, vectors and enzymes. Identification, isolation, characterization of genes and application of gene cloning. Generation of chimeric gene cassettes for producing genetically engineered transgenic plants. cDNA and genomic libraries, library screening. Molecular markers and their application. RFLP, PCR based markers. Construction of molecular maps. Marker assisted selection. Molecular mapping and tagging of agronomically important traits. Genomics and proteomics. DNA sequencing. Hybridization techniques. General application of biotechnology in agriculture. Biosafety, bioethics and intellectual property rights in biotechnology.

Biotech. 503 Principles in Structural and Functional Genomics **3+0** **Sem. I**

Development of sequence based molecular markers - SSRs and SNPs. Advanced methods of genotyping construction of high density linkage maps. Mapping genes for qualitative and quantitative traits. QTL mapping using structured populations, AB-QTL analysis, Association mapping of QTL. Fine mapping of genes/QTL. Map based gene/QTL isolation and development of gene based markers. Structural genomics: Classical ways of genome analysis, large fragment genomic libraries, Physical mapping of genomes, Genome sequencing, sequence assembly and annotation, comparative genomics. Allele mining by TILLING and Eco-TILLING and deep sequencing. Functional genomics: DNA chips and their use in transcriptome analysis. Mutants and RNAi in functional genomics. Metabolomics and ionomics for elucidating metabolic pathways. Use of markers in plant breeding. Marker assisted breeding including marker assisted back crossing, foreground and background selection, marker assisted alien introgression and transgenic breeding. Discussion on selected examples on MAS in India and global level. Applications of genomics in agriculture.

Biotech. 504 Techniques in Structural and Functional Genomics **0+2** **Sem. I**

Good lab practices. Biochemical techniques. Preparation of buffers and reagents, Principle of centrifugation, gel electrophoresis- agarose and PAGE (nucleic acids and proteins). Growth of bacterial culture and preparation of growth curve. Isolation of plasmid DNA from bacteria, restriction digestion of plasmid DNA. Isolation of high molecular weight DNA and analysis. Gene cloning - Recombinant DNA construction, transformation and selection of transformants. PCR and optimization of factors affecting PCR. Dot blot analysis. Southern hybridization, Northern hybridization, Western blotting and ELISA. Radiation safety and non-radio isotopic procedure. Molecular markers (RAPD, SSR, AFLP etc) and their analysis. Case study of SSR markers (linkage map, QTL analysis etc). SNP identification and Analysis. Microarray studies and use of relevant software. Construction of gene libraries. Synthesis and cloning of cDNA and RTPCR Analysis. Real time PCR and interpretation of data.

Biotech. 505 Techniques in Molecular Biology-II **0+2** **Sem. II**

Construction of gene libraries. Synthesis and cloning of cDNA and RTPCR analysis. Real time PCR and interpretation of data. Molecular markers (RAPD, SSR, AFLP etc) and their analysis. Case study of SSR markers (linkage map, QTL analysis etc). SNP identification and analysis. Microarray studies and use of relevant software. Proteomics (2D gels, mass spectrometry, etc.). RNAi (right from designing of construct to the phenotyping of the plant). Yeast 1 and 2-hybrid interaction. Generation and screening of mutants. Transposon mediated mutagenesis.

Biotech. 506 Molecular Cell Biology **3+0** **Sem. I**

General structure and constituents of cell. Similarities and distinction between plant and animal cells. Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions. Structure

and function of major organelles i.e. Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes, Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc. Organellar genomes and their manipulation. Ribosomes in relation to cell growth and division. Cyto-skeletal elements. Cell division and regulation of cell cycle. Membrane transport. Transport of water, ion and biomolecules. Signal transduction mechanisms. Protein targeting.

Biotech. 507/ Micro. 504 Industrial Microbiology **2+1** **Sem. II**

History, scope and development of industrial microbiology. Isolation, maintenance and genetic improvement of industrially and biotechnologically important microorganisms. Substrates for industrial fermentations. Bioreactor types. Concepts of industrial fermentations - batch and continuous. Scaling up, downstream processing and product recovery. Microbial production of ethanol, beer, wine, organic acids, enzymes, growth factors and vitamins, vinegar, low alcoholic beverages, antibiotics, lactic acid, biofuels, vaccines, Single cell protein, biogas and hydrogen production, biofertilizers, bioinsecticides, biopesticides, biodegradable plastics. Biosensors: to detect food contamination and environmental pollution. Biomining, Steroid transformation, Immobilization of cells/enzymes, Silage production, Waste disposal and treatment. Use of genetically-engineered microorganisms, Microbiologically produced food colours, pigments and flavours. Retting of flax.

Practical: Isolation, maintenance and improvement of industrial important organisms. Production of alcohol, beer, citric acid, lactic acid and their recovery; Study of bio-reactors. Production of biofertilizers and biogas. Demonstration of activity of immobilized enzymes/cells.

Biotech. 508 Nanobiotechnology **3+0** **Sem. II**

Introduction to Biomacromolecule. The modern concepts to describe the conformation and dynamics of biological macromolecules using scattering techniques, micromanipulation techniques, drug delivery applications etc. Cellular engineering. Signal transduction in biological systems, feedback control signaling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation. Chemical, physical and biological properties of biomaterials and bioresponse. Biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins). Aerosol properties, application and dynamics. Statistical Mechanics in Biological Systems, Preparation and characterization of nanoparticles. Nanoparticulate carrier systems. Micro- and Nano-fluidics. Drug and gene delivery system. Microfabrication, Biosensors, Chip technologies, Nano-imaging, Metabolic engineering and Gene therapy.

Biotech. 509 Bioinformatic Tools and their Applications in Agriculture **2+1** **Sem. I & II**

Introduction to Bioinformatics, HTML, CGI, web services, databases - primary, secondary and structural. Protein and Gene Information Resources - PIR, SWISSPROT, PDB, Genebank including NCBI, DDBJ, EMBL. Specialized crop based genomic resources. Structure of DNA, RNA, DNA sequencing, Structure of common amino acids, peptide, polypeptide, Primary, secondary and tertiary structure of proteins, biological functions of proteins, 1D and 2D- Electrophoresis and protein sequencing. DNA sequence analysis. cDNA libraries and EST, EST analysis. Pairwise alignment techniques. database searching. multiple sequence alignment. Secondary database searching. building search protocol. Introduction to softwares for SNP identification. Gene finder. Primer design. SSR finder and Phylogenetic analysis. Hidden Markov Models, Bayesian estimation and Gibbs sampling. Comparing two sequences using PAM and BLOSUM, Needleman and Wunsch algorithm, Smith-Waterman algorithm, BLAST. Solution of transcendental and polynomial equations by bisection, iteration, secant and Newton-Raphson methods, solution of system of linear algebraic equations by Gauss elimination method, Jacobi's and Gauss-Siedel iteration methods; numerical differentiation, numerical integration- Trapezoidal rule, Simpson's 1/3 and 3/8 rules.

Practical: HTML, Biological databases, Protein and Gene Information Resources, Hidden Markov Models, Bayesian estimation and Gibbs sampling. PAM and BLOSUM matrices, Needleman and Wunsch algorithm. Tutorials on bisection, iteration, secant and Newton - Raphson methods, Gauss elimination, Jacobi's and Gauss-Siedel iteration methods, numerical differentiation and numerical integration.

Biotech. 601 Advances in Genetic Engineering and Transformation **2+0** **Sem. II**

Overview of transgenic plants. Genetic engineering for herbicide, insects/pests resistance, abiotic stress tolerance and quality. Genetically engineered pollination control and induction of male sterility in plants. Molecular farming of plants for applications in veterinary and human medicine systems. Rapid production of specific vaccines. Recent developments in plant transformation and marker free strategies. Role of antisense and RNAi-based gene silencing in crop improvement. Regulated and tissue-specific expression of transgenes for crop improvement. Gene stacking. High throughput phenotyping of transgenic plants. Environmental issues associated with transgenic crops. Food and feed safety issues associated with transgenic crops. Risk assessment of transgenic food crops. Discussions on application of genetic transformation in some major field and horticultural crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane, citrus, papaya, banana etc.

Biotech. 602 Advances in Plant Molecular Biology **2+0** **Sem. I**

Arabidopsis in molecular biology, Forward and Reverse Genetic approaches. Transcriptional and post-transcriptional regulation of gene expression. Isolation of promoters and other regulatory elements. RNA interference. Transcriptional gene silencing. Transcript and protein analysis. Use of transcript profiling to study biological systems. Floral Development. Molecular basis of self incompatibility. Molecular basis of heterosis. Regulation of flowering. Molecular biology of abiotic stress responses. Molecular Biology of plant-pathogen interactions. Molecular biology of Agrobacterium infection. Molecular biology of Rhizobium infection (molecular mechanisms in symbiosis). Programmed cell death in development and defense. Molecular biology of Rhizobium infection (molecular mechanisms in symbiosis). Recent topics in plant molecular biology.

Biotech. 603 Advances in Crop Biotechnology **2+0** **Sem. II**

Conventional versus non-conventional methods for crop improvement. Present status and recent developments on molecular marker systems. Transformation and genomic tools for crop improvement. Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency, quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc). Edible vaccines. Molecular breeding- constructing molecular map. Integrating genetic, physical and molecular maps. Diversity assessment and phylogenetic analysis. Molecular tagging of genes/traits. Selected examples on marker assisted selection of qualitative and quantitative traits. Discussions on application of molecular markers and genomic tools for the genetic enhancement in some major field and horticultural crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane, banana, grapes and papaya etc.

Biotech. 604 Advances in Functional Genomics and Proteomics **2+0** **Sem. I**

Genome sequencing and functional genomics in some model plants and major field crops. Advances in genome sequence technologies. Genome annotation. Gene discovery. Functional annotation and gene family clusters. Functional analysis of genes. RNA-mediated interference. Gene knockoffs. Gene traps/T-DNA insertion lines. Homologous recombination. Microarray profiling. SAGE, SNPs/variation. Yeast-two hybrid screening. Gene expression and transcript profiling. EST contigs. EcoTILLING. Allele/gene mining. Synteny and comparative genomics. Genome evolution, speciation and domestication. Proteomics- protein annotation; protein separation and 2D PAGE. Mass spectroscopy. Protein microarrays. Protein interactive maps. Structural proteomics including protein structure determination, prediction and threading, software and data analysis/ management. Discussions on recent topics in functional genomics, proteomics and integrative genomics.

Biotech. 605/Micro. 605 Advances in Microbial Genetics and Biotechnology **2+0** **Sem. II**

Organization of genetic material in prokaryotic and Eukaryotic cell. Gene expression-DNA- protein interaction. Genetic recombination-General and specific recombination following gene transfer-transformation, transduction and conjugation. Bacterial plasmids-replication, maintenance and functions. Bacteriophages-structure, lytic and lysogenic cycle, molecular mechanism and adsorption and infection. Insertion sequences and transposons-structure, replication and application in improvement of microbial expression with respect to industry and agriculture. Molecular mechanism of site mutagenesis. Protein

engineering, recombinant DNA technology-DNA isolation, vector designing, cloning, PCR amplification, expression of genes and its application in industry and agriculture. Concepts of proteomics and genomics.

Biotech. 606 Commercial Plant Tissue Culture

2+0

Sem. I

Micropropagation of commercially important plant species. Plant multiplication, hardening, and transplantation, genetic fidelity, scaling up and cost reduction. Bioreactors. Synthetic seeds. Management and marketing. 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. Value-addition by transformation. Development, production and release of transgenic plants. Patent, bio-safety, regulatory, environmental and ethic issues. Management and commercialization. Some case studies on success stories on commercial applications of plant tissue culture.

Biotech. 607 Advances in Bioinformatics

0+2

Sem. I

Linux and Unix Operating Systems. C + +, Perl Script. Importance of Biological Databases. Searching NCBI Database using Entrez. Multiple sequence alignment using ClustalW and ClustalX. Using repeat Masker to identify repetitive elements in Genome Sequences. Finding genes using various algorithms. Finding SSRs and Designing Primers. Viewing and editing assembled sequences using Consed. Assembling Genome Sequences using PHRAP. Aligning large sequences sets. Generating Contigs using FPC. Gene Annotation. Inferring evolutionary relationships based on DNA and protein data.

Biotech. 591 Seminar

Biotech. 600 Master's Research

Biotech. 700 Ph.D. Research

AGRICULTURAL METEOROLOGY

PROGRAMMES

1. M.Sc. Agricultural Meteorology

2. Ph.D Agricultural Meteorology

COURSE REQUIREMENT

M.Sc.

Field of Specialization

Climate Change, Microclimate Modifications, Crop Modeling, Crop-weather-pests interactions.

Required Courses

Agromet. 501, Agromet. 502, Agromet. 503, Agromet. 504, Agromet.505

Supporting Courses

Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem

Minor Fields

Agronomy, Entomology, Plant Pathology, Soil Science, Math., Vegetable Science or any other as approved by the Dean, Postgraduate Studies

Deficiency courses for students with elective other than Agronomy, Soil Science, Forestry

9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization

Climate Change, Microclimate Modifications, Crop Modeling, Crop-weather-pests interactions.

Required Courses

Agromet.601 , Agromet. 602, Agromet.603

Supporting Courses

Stat. 515 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem

Minor Fields

Agronomy, Entomology, Plant Pathology, Soil Science, Math., Vegetable Science or any other as approved by the Dean, Postgraduate Studies

Deficiency courses for students with M.Sc. (Agri.) in a discipline other than Agricultural Meteorology

Agromet. 501, Agromet. 502, Agromet. 503, Agromet. 504, Agromet.505 and other courses as recommended by Student's Advisory Committee

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Agromet. 102 Introductory Agrometeorology **2+1 Sem. I & 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.

Postgraduate Courses

Agromet. 501 General Meteorology and Climatology **2+1 Sem. I**

Solar radiation & heat balance. Pressure and temperature, potential temperature. Cyclones and anticyclones. Equations of motion. General circulation, turbulence, vorticity, atmospheric waves. Gas and thermodynamic laws. Water vapour in the atmosphere. Stability and instability. Lapse rates-ascent of dry and moist air, condensation. Clouds. Hydrological cycle- precipitation processes, artificial rainmaking, thunderstorms and dust storms. Air masses and fronts. Zonal distribution of radiation, rainfall, temperature and wind. SE Asian monsoon. El Nino, La Nina and ENSO. Weather forecasting importance, types, tools and techniques of weather forecasting. Measures of central tendency and dispersion, correlation, regression, moving average probability and their distribution functions. Analysis of weather systems.

Practical: Agromet observatory-different classes of observatories. Site selection and installation procedures for meteorological instruments. Measurement and recording of weather parameters. Climatic normals, weather chart preparation and identification of low and high pressure systems. Statistical techniques for computation of normals, moving average, Markov chain model etc.

Agromet. 502 Applied Agricultural Meteorology **2+1 Sem. II**

Meaning, scope and components of agricultural meteorology. Importance of meteorological parameters in agriculture. Efficiency of solar energy conversion into dry matter production. Air pollution and its influence on vegetation. Meteorological factors in photosynthesis, respiration and net assimilation. Basic principles of water balance, soil-water balance models and water production functions. Crop weather calendars. Weather forecasts for agriculture. Agromet advisories. Weather forecasting techniques. Drought-concepts and types. Crop water stress index and crop stress detection. Role of meteorological parameters in air pollution. Crop- weather-pest interactions. Meteorological aspects of forest fires and their control. Concepts of statistical and simulation models. Climatic change and 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.

Agromet. 503 Micrometeorology **2+1 Sem. II**

Properties of atmosphere. Exchange of mass and momentum. Similarity hypothesis, shearing stress and convection. Temperature instability, unstable and inversion layers. Variation in microclimate under bare ground, plant canopies under irrigated and rainfed conditions. Richardson number and Reynolds analogy. Exchange coefficients. Modification of microclimate. Radiation distribution in plant communities.

Leaf temperature and its biological effects. Microclimate in low plant area of meadows, grain fields, forests, glass house and plastic houses. Instruments and measuring techniques in micrometeorology. Effects of ambient weather conditions on growth, development and yield of crops. Energy balance over crops. Remote sensing in relation to micrometeorology.

Practical: Micrometeorological measurements in crop canopies. Quantification of crop microclimate. Measurement of net radiation, albedo, global and diffuse radiation. PAR distribution in plant canopies and interception. Wind, temperature and humidity profiles. ET computation.

Agromet. 504 Agrometeorological Measurements and Instrumentation **2+1** **Sem. I**

Fundamentals of measurement techniques. Theory and working principles of barometers, thermometers, psychrometers, hair hygrometer, thermohygrograph, radiation and temperature instruments, pressure bomb apparatus, precipitation and dew instruments, wind instruments, porometer, photosynthesis system, leaf area meter, soil thermometers and soil heat flux plates. Automatic weather station. Computation and interpretation of data.

Practical: Working with the above instruments in the meteorological observatory, taking observations of relevant parameters. Exposure and operation of meteorological instruments/equipments in agromet observatories. Computation and interpretation of the data.

Agromet. 505 Soil Water Balance Climatology **2+1** **Sem. II**

Basic laws of radiation, radiation interaction with plant environment. Energy balance in atmosphere and crop canopy. Fundamentals of soil water movement and fluid flow. Soil heat concepts. Theories and methods of ET estimation. Concepts of potential, reference and actual evapotranspiration - modified techniques. Influence of microclimatic, plant, soil and cultural factors on ET. Techniques of lysimetry in measuring actual ET. Yield functions, water use efficiency and scheduling of irrigation based on ET. Water use efficiency and anti-transpirants. Dry matter yield, ET functions. Advanced techniques for measurement of radiation and energy balance; computation of KC values and their use. Modeling for potential ET & reference ET and ET through remote sensing.

Practical: Measurement and evaluation of radiation components. Computation and comparison of evapotranspiration by different methods - energy balance method, aerodynamic method, Penman method, remote sensing and other methods. Measurement of wind and temperature profiles near the ground

Agromet. 506 Crop Weather Models **2+1** **Sem. I**

Basic concepts and definitions related to modelling. Principles of crop production. Evaluation of crop responses to weather elements. Impact of natural and induced variability of climate on crop production. Empirical and statistical crop weather models, their application with examples. Regression models-incorporating weather, soil, plant and other environmental related parameters and remote sensing inputs. Growth and yield prediction models. Crop simulation models-DSSAT models, WOFOST, SPAW, INFOCROP etc. Yield forecasting models, insect forecasting and disease forecasting models. Testing of models- Verification, calibration, sensitivity analysis and validation of models.

Practical: Working with statistical and simulation models, DSSAT models, BRASSICA etc.

Agromet. 507 Weather Modification and Risk Management Strategies **2+0** **Sem. II**

Weather modification- historical review, present status and theories. Atmospheric composition and green house effect. Scientific advances in clouds and electrical behaviour of clouds. Modification of weather hazards. Modification of field microclimate. Protection of plants against climatic hazards. Meteorological conditions in artificial and controlled climates. Risks in agricultural production, history, trends and strategies, preparedness for weather and climate risks. Risk characterization - definitions and classification in agriculture. Risks related with water, radiation/heat, air, biomass, social and economic risk factors related to weather and climate. Methods for risk assessment and application to agricultural systems. Application of risk management approaches to weather and climate problems. Application of methods that permit the incorporation of seasonal and long-term forecasts into the risk assessment models.

Agromet. 508 Principles of Remote Sensing and their Applications in Agriculture **2+1** **Sem. I**

Basic components of remote sensing. Characteristics of electromagnetic radiation and its interaction with matter. Spectral features of earth's surface. Sensor Systems. Data acquisition

system, data pre-processing, storage and dissemination. Digital image processing and information extraction. Fundamental of aerial photographs. Microwave remote sensing. Visual and digital image interpretation. Introduction to GIS and GPS. Application of Remote Sensing Techniques-crop identification, crop stress detection, yield forecasting, soil moisture, air temperature assessment, drought monitoring, wasteland identification, management & monitoring of crop disease and pest infestation. Analysis of spatial & temporal variability in soils, agroclimatic regionalization.

Practical: Field data collection. Map and imagery scales. S/W and H/W requirements and specifications. 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.

Agromet. 509 Applied Agricultural Climatology

2+1

Sem. II

Climatic statistics. Assessment of frequency of disastrous events. Hydrological cycle. Climatic water budget. Potential and actual ET. 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. Thermal indices and phenology. Cardinal temperatures. Growing degree day concept and applications. Crop weather calendars. Agroclimatic requirements of crops. Bioclimatic concepts- evaluation of human comfort, indices and clothing insulation. Climate housing and site orientation. Climatic normals for animal production.

Practical: Statistical approaches in data analysis. Preparation of climatic water budget. Estimation of agro-meteorological variables using historical records. Degree day concept and phenology forecasting, crop calendar and climograph. Weather-pest-disease interactions, calculation of continentality factors and comfort indices.

Agromet. 601 Advanced Weather Forecasting

3+0

Sem. I

Weather forecasting - definition, importance, scope and types. Study of synoptic charts, jet streams, synoptic features and weather anomalies and zones of thermal advection and interpretation of satellite pictures of clouds. Weather forecasting network. Approaches of weather forecasts. Indigenous Technical Knowledge. Weather based advisories. Interpretation of weather forecasts for soil moisture, farm operations, pest and disease development and epidemics, crops and livestock production. Special forecasts for natural calamities. Modification of weather hazards, weather modification for agriculture. Scientific advances in artificial rain making, hail suppression, dissipation of fog and stratus clouds, modification of severe storms and electric behaviour of clouds. Synoptic chart analysis. The kinematics of the pressure field. The atmospheric scales of motion. Global circulations. Perturbation theories of instability. Jet streams. Cloud identification and characterization from satellites.

Agromet. 602 Analytical Tools and Methods for Agricultural Meteorology

3+0

Sem. II

Review of agro-climatic methods. Characterization of agroclimatic elements. Sampling of atmosphere - temporal and spatial considerations. Micro, meso and macro climates. 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. Hysteresis effects. 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. Instrumentation and sampling problems. Design of agro-meteorological experiments. Basic knowledge of applications of computers in agriculture. Empirical and statistical crop weather models and their application with examples. Incorporating weather, soil, plants and other environment related parameters as subroutine and remote sensing inputs in models. Growth and yield prediction models, crop simulation models and forecasting models for insects and diseases.

Agromet. 603 Strategic Use of Climate Information

3+0

Sem. II

Awareness and history of climate-related disasters. Hazards and their relation to agricultural production risks and their mitigation. Selection of appropriate land use and cropping patterns- history and environmental issues, success and difficulties experienced by farmers and outlook for possible alternatives. Agro-

meteorological aspects for making more efficient use of agricultural inputs. Selection of livestock management- history related to environmental issues. Adoption of microclimate modification techniques. 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.

Agromet. 604 Climate Change and Sustainable Development **2+0** **Sem.I**

Climate change and variability. Driving forces and patterns in climatic changes. Green house effect. Green house gases and global warming. Types of air pollutants. Role of air pollutants in climate change. Meteorological factors in the movement of dispersion of air pollutants & biochemical smog. Natural and human caused climate change. Induced climate change due to change in land use pattern. Implications of climate change for agriculture. Global strategy to minimize climate change process. Role of climate change models. Effects of climate change on agriculture, biodiversity etc. Mitigation and adaptation strategies in agriculture. Advances in climate change. Mitigation strategies in agriculture to counteract climate change. Models for climate change studies.

Agromet. 605 Advanced Micrometeorology **2+0** **Sem.II**

Energy flow in the plant environment system. Momentum, heat and mass transfer in the biosphere. Soil heat flux. Aerial and crop resistance affecting energy transport. The movement of particles in plant communities. Derivations of crop growth processes based on micrometeorological data. Energy balance over different crops. Microclimate in fields, forests, glass house and net houses/plastic houses. Field climate modification-methods of modification in crops. Risk analysis in environmental modifications. Recent advances in field climate modifications.

Agromet. 606 Agrometeorological Data Base Management and e-Services **2+1** **Sem. I**

Data, information and types of data-climate, soil and crop data. Importance of database management, data requirements, collection and recording. Data structure/format and quality control of data. Techniques of climatic data generation and missing data. Introduction to different software for database management. Processing and analysis of data and data products. Value addition of data and data products- data users, public, commercial, academic / research. Availability, accessibility and security of data. Evaluating the cost of data.

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. Uploading and downloading data, password and security of data. E-management of data.

Agromet. 591 Seminar

Agromet. 600 Master's Research

Agromet. 700 Ph.D. Research

AGRONOMY

PROGRAMMES

1. M.Sc.

2. Ph.D.

COURSE REQUIREMENT

M.Sc.

Field of Specialization

Agrostology, Crop Ecology, Crop Nutrition, Crop Physiology, Crop Production, Water Management, Weed Science

Required Courses

Agron.501, Agron. 502, Agron. 503, Agron. 504, Agron.505

Supporting Courses

Stat.421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem

Minor Fields

Agrometeorology, Chemistry, Botany, Soil Science, Forestry & Natural Resources, Microbiology or any other as approved by the Dean, Postgraduate Studies

Deficiency courses for students with elective other than Agronomy, Soil Science, and Forestry

9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization

Agrostology, Crop Ecology, Crop Nutrition, Crop Physiology, Crop Production, Water Management, Weed Science

Required Courses

Agron. 601, Agron. 602, Agron. 603, Agron. 604

Supporting Courses

Courses from subject matter fields (other than minor) relating to area of special interest and research problem

Minor Fields

Agrometeorology, Chemistry, Botany, Soil Science, Forestry & Natural Resources, Microbiology or any other as approved by the Dean, Postgraduate Studies

Deficiency courses for students with M.Sc.(Agri.) in a discipline other than Agronomy

Agron.501, Agron. 502, Agron. 503, Agron. 504, Agron.505 and other courses as recommended by Student's Advisory Committee

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Agron. 91 Agronomy-I	2+1	Sem.I
<p>Agriculture, its importance and branches; climate, soil and water in relation to crop production; farm tools and implements; crop seasons; seed structure and germination; phases of plant growth and factors affecting it; mode of propagation; classification and relative status of important crops in the state; importance of water to plants; agronomic practices, seed bed preparation, sowing, fertilizer application; weed control, harvesting, thrashing and marketing of important field crops.</p> <p>Practical: Land measurements; seed bed preparation; interculture techniques; identification of field crops, their seeds and important weeds; germination of different crop seeds in lab. and field; depth of seed placement in relation to seed size; methods of irrigation; familiarization of agricultural hand tools and implements; maintenance and keeping farm records.</p>		
PFT-91 Practical Field Training-I	0+1	Sem I
PFT-92 Practical Field Training-II	0+1	Sem II
Agron.101 Elements of Agronomy	2+1	Sem I
<p>(For students of B.Sc. Biotech (Hons.) and B.Tech Food (Hons.)-4 year programme)</p> <p>Agriculture-history and development. Agronomy - its relation with other sciences. Classification of crops. Tillage-principles and practices. Methods of sowing - suitability under different conditions, seeding practices in relation to kind of seed, time of sowing, soil moisture etc. Weeds-characteristics, losses caused, dissemination, competition and their methods of control. Irrigation-principles and practices. Dryland farming. Maintenance of soil fertility and productivity- organic manures, fertilizers and their application. Green manuring. Crop rotations. Multiple cropping. Mixed cropping and intercropping.</p> <p>Practical: Land measurement, judging of soil texture and 'water'. Field preparation, making of plots, ridges and raised beds. Identification of crops, weeds, seeds and fertilizers. Use of hand tools and implement, Computation of fertilizer doses and their methods of application. Incorporation of crops for green manuring. Practice in sowing methods and use of seed drills. Harvesting of different crops. Farm visits for acquaintance with field problems.</p>		
Agron. 105 Agriculture for Engineers	3+1	Sem. I
<p>(In collaboration with Department of Soil Science, Fruit Science and Vegetable Science) (For students of College of Agricultural Engineering & Technology)</p> <p>Soil Science: Concept of soil & soil components. Minerals : definition, composition and classification. Rock: definition, composition and classification; Factors of soil formation, parent materials, topography, time, climate and organisms; Soil forming processes, humification, eluviations, illuviation, clacification, gleization, salanization, alkalisation, laterization, podzolization; Physical properties of soil and their importance; Soil colloids, properties and types, structure of silicate and non-silicate colloids; Types of ion exchange; principles governing cation exchange reactions, cation exchange capacity and factors affecting it, cation saturation and nutrient availability; Soil organic matter; composition, decomposition and mineralization; role of organic matter on soil fertility; Soil reaction: concepts, factors affecting soil reaction and its role in nutrient available; characteristics and management of acid, saline and alkali soils; Quality of irrigation water: criteria and guidelines for evaluation of quality of irrigation water; Essential plant nutrients: their functions and deficiency symptoms in plants.</p> <p>Practical: Identification of rocks & minerals, Examination & description of soil profile, Determination of particle density, bulk density and porosity of soils, Determination of pH and electrical conductivity of soils. Determination of organic carbon of soils.</p> <p>Agronomy: Definition and scope of agronomy. Classification of crops, Effect of different weather parameter on crop growth and development. Soil water plant relationship and water requirement of crops, Weeds and their control, Crop rotation, Cropping systems, Relay cropping and mixed cropping. Practical: Identification</p>		

of crops and their varieties seeds and weeds, Fertilizer application methods, Different weed control methods, Judging maturity time for harvesting of crop, study of seed viability and germination test.

Horticulture: Scope of horticulture crops, soil and climatic requirements for fruits, Improved varieties of fruits, Criteria for site selection for fruits crops, layout and planting methods for fruit plants, nursery raising for fruit crops, Macro and micro propagation methods for fruits plants, plant growing structures, Pruning and training of fruit plants, Manuring and fertilization and fertigation in fruit plants, irrigation methods for fruit plants, Grading and packing of fruits, post harvest practices for fruit crops, Garden tools, Management of orchards.

Practical: Identification and description of fruit plants and varieties, Study of different garden tools and preparation of nursery bed, Practices of pruning and training of important fruit crops. Vegetable Science : Branches of Horticulture, definitions, scope of vegetable cultivation and importance of vegetables in human nutrition, Cultivation of potato: climate, soil, varieties, sowing, seed rate, method of sowing, diseases and pests, seed plot technique, harvesting and post-harvest handling, Cultivation of tomato; climate, soil requirement, time of sowing, transplanting, varieties nursery raising, frost protection, spacing, irrigation, picking and post harvest handling. Cultivation of brinjal; soil and climate requirement, nursery raising, varieties, sowing, transplanting, spacing, plant protection and storage., Cultivation of chilli and capsicum: climate, soil, nursery raising, seed rate, spacing, varieties, hybrid seed production, frost and plant protection, post-harvest handling, Cultivation of root crops; radish, carrot and turnip, their sowing time, seed rate, climate, soil, varieties, spacing, irrigation, nutrients, application, harvesting and marketing. Cultivation of cucurbitaceous crops; climate, nursery raising, seed rate, spacing, varieties, nutrient application, picking and storage.

Practical: Nursery raising and transplanting, Cultivation of potato, root crops and fruit vegetables.

Agron. 106 Water Management and Microirrigation **2+1** **Sem. II**

Irrigation- definition and objectives. Water resources and irrigation development in India and Punjab. Plant water relationships. Crop water requirement and their determination methods. Effective rainfall, mulching and criteria of scheduling irrigation. Methods of irrigation- surface, sprinkler and drip irrigation. Irrigation efficiency. Conjunctive use of water. Water management in rice, wheat, maize, cotton, groundnut, sugarcane, mango, banana and tomato. Agricultural drainage.

Practical: Determination of bulk density and field capacity by field methods. Determination of permanent wilting point. Measurement of irrigation water through flumes and weirs. Calculation of irrigation water requirement. Demonstration of furrow, check basin and basin methods of irrigation. Cost estimation of drip irrigation system. Demonstration of filter cleaning, fertigation, injection and flushing of laterals. Erection and operation of sprinkler irrigation system.

Measurement of emitter discharge rate, wetted diameter and calculation of emitter discharge variability. Visit to farmers' field.

Agron. 203 Principles of Agronomy-I (Kharif Crops) **2+1** **Sem. I**

Meaning and scope of Agronomy. Tillage and crops stand establishment. Planting geometry and its effect on growth and yield. Cropping systems. Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of kharif crops- rice, maize, sorghum, pearl millet, minor millets, pigeonpea, mungbean, urdbean, groundnut, sesame, soybean, cotton, jute, sunhemp and forage crops -sorghum, maize, cowpea, cluster bean and napier.

Practical: Study of tillage implements. Practice of ploughing and puddling. Seed bed preparation, sowing, fertilizer application, nursery raising and transplanting of Kharif crops.

Calculations of seed rate. Effect of seed size and sowing depth on germination. Identification of weeds of Kharif crops. Fertilizer experiments on rice, maize, sorghum and millets. Study of yield components. Study of crop varieties and important agronomic experiments. Study of forage crops.

Agron. 204 Principles of Agronomy -II (Rabi Crops) **2+1** **Sem. II**

Origin, geographic distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of rabi crops- wheat, barley, chickpea, lentil, peas, french bean, rapeseed and mustard, sunflower, safflower, linseed, sugarcane, sugarbeet, potato, tobacco and forage crops- berseem, lucerne and oats. National and International Agricultural Research Institutes in India.

Practical: Study of manures, fertilizers and green manure crops. Study of interculture implements. Methods of fertilizer application. Seed bed preparation and sowing of wheat, sugarcane and sunflower. Calculations of seed rate. Identification of weeds in wheat and grain legumes. Morphological characteristics of wheat, sugarcane, chickpea and mustard. Yield components of wheat and sugarcane.

Agron. 205 Organic Farming **1+1** **Sem. II**

(In collaboration with Department of Soil Science, Entomology and Plant Pathology) Organic farming-introduction, concept, relevance in the present context. Organic production requirements. Biological intensive nutrient management. Recycling of organic residues. Soil improvement and amendments. Integrated diseases and pest management. Use of biocontrol agents, biopesticides, pheromones, trap crops and bird perches. Weed management. Quality considerations - certification, labeling and accreditation processors, marketing and exports. Practical: Raising of vegetable crops through organic sources. Diseases and pest management. Vermicomposting. Vegetable and ornamental nursery raising. Macro quality analysis. Grading, packaging and post harvest management.

Agron. 301 Practical Crop Production-I (Kharif Crops) **0+2** **Sem. I**

Crop planning. Raising field crops in multiple cropping systems using improved agronomic practices. Field preparation, seed treatment, nursery raising, sowing. Management of nutrient, water, weed, insect pests and diseases of crops. Harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student.

Agron. 302 Practical Crop Production-II (Rabi Crops) **0+2** **Sem. II**

Crop planning. Raising field crops in multiple cropping systems using improved agronomic practices. Field preparation, seed treatment, nursery raising, sowing, nutrient management, water management, weed management and management of insect pests and diseases of crops. Harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student.

Agron. 303 Crop Residue Management **2+0** **Sem. II**

Significance of crop residue management. Challenges for diversified use of crop residue in high cropping intensity areas. Crop residue in relation to agricultural ecosystems and conservation agriculture. On-site and off-site management of crop residues and soil health indicators. Beneficial effects of crop residue on soil health, crop yields, social and environmental concerns. Recent technologies for conservation agriculture. Policy options for efficient residue management in Punjab.

Undergraduate Elective/M.Sc. Supporting/Minor Courses

Agron. 433 Weed Management **2+1** **Sem. I**

Weeds- Introduction, harmful and beneficial effects, characteristics and classification. Weed biology and ecology. Crop weed association, competition and allelopathy. Concepts of weed prevention, control and eradication. Methods of weed control. Physical, cultural, chemical, biological and integrated weed management. Herbicides- classification, formulation, advantages, disadvantages and methods of application. Introduction to adjuvants and their use in herbicides. Introduction to selectivity of herbicides. Mode of action and fate of herbicides in soil. Compatibility of herbicides with other agrochemicals. Weed management in major field and horticultural crops and in non cropped areas. Shift in weed flora in cropping systems. Classification, useful and harmful aspects and control measures of aquatic weeds. Problematic weeds and their control.

Practical: Identification of weeds and weed seeds. Survey of weeds in crop fields and other habitats. Preparation of weed herbarium. Computation of herbicide doses, weed control efficiency and weed index. Methods of recording weed intensity under different situations. Herbicide label information of commonly available herbicides. Herbicide application equipments and their calibration. Diagnosis of herbicide toxicity symptoms in different crops and weeds. Visits to problem areas.

Agron. 434 Farming Systems and Sustainable Agriculture **2+1** **Sem. I**

Farming systems, definition, principles and components. Farming System models for irrigated, dryland situations and modules for marginal, small and large farmers. Farming systems of the world-arable,

pastoral, lay farming, shifting cultivation, ranching and agro-forestry systems. Energy and fuel wood plantations. Specialized and diversified farming, family co-operative and collective farming: their occurrence, adaptations and weaknesses. Factors affecting choice of farming systems. Cropping systems, their characteristics and management. Cropping patterns. Agro-ecosystem and agro-ecological zones of India. Efficient food producing systems. Sustainable agriculture- Introduction, definition, goal and current concepts, factors affecting ecological balance and ameliorative measures, land degradation and conservation of natural resources.

Practical: Preparation of cropping scheme and integrated farming system models for irrigated and dryland situations. Preparation of enriched Farm Yard Manure and Vermicompost. Visit to urban waste recycling unit, organic farm and model farmers' field. Preparation of farm lay out plans, different intensity crop rotations and cropping schemes. Estimating crop yields. Energy budgeting in different crops and cropping systems. Working out ecological optimum crop zones. Project making exercises for establishment of crop production farms under different situation.

Agron. 435 Production Technology of Spices, Aromatic, Medicinal and Plantation Crops 2+1 Sem. I

Important Spice crops- Ginger, Turmeric, Dill Seed, Pepper, Cardamom, Coriander, Cumin, Fennel, Celery and Fenugreek. Aromatic crops- Mentha, Lemongrass, Citronella, Palmarosa, Vetiver and Geranium. Medicinal plants- Dioscoria, Rauwolfia, Opium, Periwinkle, Guggal, Belladonna, Nuxvomica, Solanum nigrum, Senna, Amla, Isabgol, Coleus, Acorus and Pipli (mug); Plantation crops- Coconut, Arecanut, Betelvine, Cashew, Cocoa and Coffee with special reference to their origin and distribution, adaptation, classification, growth and development in relation to environment, climatic requirements, varieties, agronomic practices for sustained production, harvesting, processing marketing and quality aspects and uses.

Practical: Identification of crops based on morphological and seed characteristics. Propagation, seed selection, seed treatment, processing and distillation techniques for different medicinal, aromatic and spice crops.

Postgraduate Courses

Agron. 501 Modern Concepts in Crop Production 3+0 Sem. I

Crop growth analysis in relation to environment. Agro-ecological zones of India. Quantitative agro-biological principles and inverse yield nitrogen law. Mitscherlich yield equation, its interpretation and applicability, Baule unit. Effect of 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. Scientific principles of crop production and crop response production functions. Concept of soil plant relations. Yield and environmental stress. Integrated farming systems. Organic farming. Resource conservation technology including modern concept of tillage, dry farming. Determining the nutrient needs for yield potentiality of crop plants. Concept of balanced nutrition and integrated nutrient management. Crop residue management-recycling and its effective utilization. Remote sensing for yield forecasting. Precision agriculture.

Agron. 502 Fertilizer use in Crop Production 2+0 Sem. I

Crop response to fertilizer-effect on germination, growth and nutrient removal. Problems of supply and availability of nutrients, relation between nutrient supply and crop growth. Organic farming - basic concepts and definitions. Preparation and use of farmyard manure, compost, green manures, vermin-compost, bio-fertilizers and other organic concentrates their composition, availability and crop responses, recycling of organic wastes and residue management. Commercial fertilizers, composition, relative fertilizer value and cost. Crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades. Agronomic, chemical and physiological methods of increasing fertilizer use efficiency. Nutrient interactions. Time and methods of manures and fertilizers application. Foliar fertilizer application and its concept. Relative performance of organic and inorganic manures. Economics of fertilizer use. Integrated nutrient management. Site specific nutrient management. Effect of fertilizers on environment, Nutrient cycling integrated farming systems, Long effects of fertilizers use on crop yield and soil productivity.

Agron. 503 Principles and Practices of Weed Management**2+1****Sem.II**

Weed biology, ecology and crop-weed competition including allelopathy. Principles and methods of weed control. Weed indices. History and development of herbicide. Classification and selectivity of herbicides based on chemical, physiological application and selectivity. Mode and mechanism of action of important herbicides. Herbicide structure- activity relationship and factors affecting the efficiency of herbicides. Herbicide formulations and mixtures. Weed control through bio-herbicides, myco-herbicides and allelochemicals, Degradation of herbicides in soil and plants. Herbicide resistance in weeds and crops herbicide rotations. Weed management in major crops and cropping systems. Management of parasitic weeds and special weed problems. Weed shifts in cropping systems. Aquatic and perennial weed control. Integrated weed management. Cost: benefit analysis of weed management.

Practical: Identification of important crop weeds. Preparation of a weed herbarium. Weed survey in crops and cropping systems. Crop-weed competition studies. Weed indices. 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 residue analysis in plant and soil. Bioassay of herbicide residue. Calculation of herbicidal requirement.

Agron. 504 Principles and Practices of Water Management**2+1****Sem. I**

Water and its role in plants, water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states. Soil water movement in soil and plants, transpiration, soil-water-plant relationships and water absorption by plants. Plant response to water stress. Soil, plant and meteorological factors determining water needs of crops, scheduling, depth and methods of irrigation, micro irrigation system. Fertigation, management of water in controlled environments and polyhouses. Water management of the crops and cropping systems. Quality of irrigation water and management of saline water for irrigation. Water use efficiency. Excess of soil water and plant growth, water management in problem soils. Drainage requirement of crops, methods of field drainage, their layout and spacing. Practical: Measurement of soil water potential by using tensiometer, pressure plate and membrane apparatus. Soil-moisture characteristics curves. Water flow measurements using different devices. Determination of irrigation requirements. Calculation of irrigation efficiency. Determination of infiltration rate. Determination of saturated/ unsaturated hydraulic conductivity. Determination of Consumptive use, water requirement of a given cropping pattern.

Agron. 505 Field Plot Techniques**2+1****Sem.II**

Planning field experiments-objectives, selection of field and treatment. Conduct of the experiment, precautions during sowing, management, harvesting and threshing. Sampling. Recording biometrical observations. Sources of error in the field experiments and methods of reducing it. Optimum plot size and number of replications. Selection of experimental designs. Rotational experiments. Experiments to study the effect of years and locations. Compilation, presentation and interpretation of the data. Factorial experiments and interaction effects. Different tests of significance. Correlation and response functions. Transformation of data. Practical: Actual layout of field experiments. 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. 506 Agronomy of Major Cereals and Pulses**2+1****Sem.II**

Origin, history, area, production, classification, morphology, phenology, physiology, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of kharif and rabi cereals and pulses (rice, maize, sorghum, millets, wheat, barley), important grain legumes (pigeonpea, mungbean, urdbean, chickpea and lentil).

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 of prominent intercropping systems of different crops; Estimation of protein content in pulses; Planning and layout of field experiments; 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 various crops; Visit of field experiments.

Agron. 507 Agronomy of Oilseed, Fibre and Sugar Crops **2+1** **Sem.I**

Origin and history, area and production, classification, morphology, phenology, physiology, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of kharif and rabi oilseed crops (Groundnut, sesame, castor, sunflower, soybean, rapeseed and mustard, linseed, etc.), fibre crops (Cotton, jute, sunhemp etc.) and sugar crops (Sugar-beet and sugarcane etc.). Practical: Planning and layout of field experiments. Cultivation of sugarcane crop and estimation of its quality parameters. Intercultural operations in different crops; Cotton seed treatment; Working out growth indices of prominent intercropping systems; 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.

Agron. 508 Agronomy of Medicinal, Aromatic and Under-utilized Crops **2+1** **Sem.I**

Importance of medicinal, aromatic, plantation and under-utilized crops in national economy and their classification. Description, distribution, climate, soil requirements, cultural practices, processing and important constituents/ quality of medicinal, aromatic, plantation and under-utilized crops, viz. Aloe, Satavar, Stevia, Safed musli, Kalmegh, Asaphoetida, Amla, Bael, Vanilla, Isabgol, Mentha, Basil, Lemongrass, Citronella, Palmarosa, Rose, Patchuli, Geranium, Rice bean, Lathyrus, Sesbania, Clusterbean, French bean, Celery, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco.

Practical: Identification of crops based on morphological and seed characteristics; Raising of herbarium of medicinal, aromatic and under-utilized plants; Quality characters in 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**

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like maize, bajra, guar, cowpea, oats, barley, berseem, senji, lucerne etc. and forage crops like, napier grass, panicum, lasiuras, cenchrus etc. Year-round fodder production and management, preservation and utilization of forage and pasture crops. 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. Economics of forage cultivation uses and seed production techniques.

Practical: Farm operations in raising fodder crops; Canopy measurement, yield and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose 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 Cropping Systems and Organic Farming **3+0** **Sem. II**

Cropping systems- definition, indices and its importance. Physical resources, soil and water management in cropping systems, assessment of land use. Concept of sustainability in cropping systems, scope and objectives. Production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping. Mechanism of yield advantage in intercropping systems. Multi-storied cropping and yield stability in intercropping. Role of non-monetary inputs and low cost technologies. Research need on sustainable agriculture. Crop diversification for sustainability. Organic farming - concept and definition, its relevance to India and global agriculture and future prospects. Soil fertility- nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers. Farming systems, crop rotations, intercropping in relation to maintenance of soil productivity. Control of weeds, diseases and insect pests- management biological agents, pheromones and biopesticides. Socio-economic impacts. Marketing and export potential, Organic standards, certification, labeling and accreditation procedures. Organic farming and national economy.

Agron. 511 Dryland Farming and Watershed Management **2+1** **Sem II**

Definition, concept and characteristics of dry land farming. Dry land versus rainfed farming. Significance

and dimensions of dry land farming in Indian agriculture. 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. Stress physiology and resistance to drought, adaptation of crop plants to drought and drought management strategies. Preparation of appropriate crop plans for dry land areas, mid contingent plan for aberrant weather conditions. Tillage, tillage 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. Concept of watershed resource management, problems, approach and components. Plant ideotypes for drylands.

Practical: Seed treatment, seed germination and crop establishment in relation to soil moisture contents, moisture stress effects and recovery behaviour of important crops, estimation of moisture index and aridity index; spray of anti-transpirants and their effect on crops, collection and interpretation of data for water balance equations, water use efficiency, preparation of crop plans for different drought conditions. Study of field experiments relevant to dryland farming, visit to dryland and soil conservation research stations and watershed projects.

Agron. 512 Conservation Agriculture **2+0** **Sem. II**

Conservation agriculture definition, status and prospects. Its role towards natural resources management and sustainability concerns. Concept of conservation agriculture and their fulfillment using tillage and crop residue management, efficient cropping systems, water and nutrients management, and integrated pest management. Relevance of conservation agriculture under changing climatic conditions. Impact of conservation agriculture on soil health and crop productivity. Conservation agriculture under rainfed / dry land farming.

Agron. 601 Advanced Trends in Agronomy **2+0** **Sem. I**

Agro-physiological basis of variation in yield. Recent advances in soil- plant- water relationship. Globalization of agriculture and WTO. Precision agriculture. Contract farming. Organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures. Crop residue management in multiple cropping systems. Latest developments in plant management, weed management, cropping systems, grassland management and allelopathy. GIS, GPS and remote sensing for crop management. Global warming. GM crops. Seed production technology. Seed certification, seed multiplication, hybrid seed production etc. Concepts of system agriculture, holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

Agron. 602 Advanced Crop Ecology **2+0** **Sem.I**

Concept of crop ecology, agricultural systems and ecology of cropping systems. Principles of plant distribution and adaptation. Crop and world food supply. Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity and biomass. Succession and climax concept. Physiological response of crop plants to light, temperature, CO₂, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops. Effect of global climate change on crop production. Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production. Competition in crop plants. Environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices. Improvement of unproductive lands through crop selection and management.

Agron. 603 Advanced Irrigation Management **2+0** **Sem.II**

Water resources of India, irrigation projects, irrigation needs. Atmospheric, soil, agronomic, plant and water factors affecting irrigation need, water deficits and crop growth. Transpiration, evapo-transpiration, significance, energy utilization of transpiration, physiological processes and crop productivity. Infiltration, water movement under saturated and unsaturated conditions. Management practices for improving water use efficiency of crops. 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. Strategies of using

limited water supply. Factors affecting ET, control of ET by mulching and use of anti-transpirants. Fertilizer use in relation to irrigation. Land suitability for irrigation, land irrigability classification. Integrated water management, institution and farmer's participation in command areas and irrigation legislation.

Agron. 604 Advanced Weed Management **2+0** **Sem.II**

History of herbicide development and registration procedures. Crop-weed competition in different cropping situations. Changes in weed flora, various causes and effects. Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action, selectivity of herbicides and factors affecting them. Classification, selectivity, chemical structures of different group of herbicides. Bioherbicides, biological agents and allelochemicals for weed control. Absorption, translocation, metabolism and mode of action of herbicides.

Climatic factors and phytotoxicity of herbicides. Fate of herbicides in soil and plants and factors affecting them, residue management of herbicides and adjuvants. Advances in herbicide application techniques. Herbicide resistance and shift in weed flora. Antidotes and crop protection compatibility of herbicides of different groups with other pesticides. Development of transgenic herbicide resistant crops. Relationship of herbicides with tillage, fertilizer and irrigation. Hazards of herbicide use and environment pollution. Bioassay and analytical techniques for herbicide residue. bioherbicides, allelochemical herbicide bioassays.

Agron. 605 Advanced Crop Growth and Productivity **2+0** **Sem.I**

Physiological limitations to crop yield. Growth analysis- concept, indices, validity and limitations. Growth curves, sigmoid, polynomial and asymptotic. Root systems, root-shoot relationship. Principles involved. Concept and differentiation of inter and mixed cropping, criteria in assessing the yield advantages. Competitive relationship and competition functions, biological and agronomic basis of yield advantage. Physiological principles of dry land crop production, constraints and remedial measures. Heat unit concept of crop maturity, and its types. 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 crop production.

Agron. 606 Integrated Farming Systems for Sustainable Agriculture **2+0** **Sem. II**

Farming systems- concept, classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises. Concept of sustainability in farming systems, efficient farming systems, natural resources - identification and management. Production potential of different components of farming systems; interaction and mechanism of different production factors, stability in different systems through research. Eco-physiological approaches to intercropping. Simulation models for intercropping, soil nutrient in intercropping, preparation of different farming system models. Evaluation of different farming systems. New concepts and approaches of farming systems and cropping systems and organic farming, case studies on different farming systems. Role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system for sustainable agriculture.

Agron. 607 Stress Crop Production **2+0** **Sem. I**

Stress and strain terminology, nature and stress injury and resistance, causes of stress. Low and high temperature stress- freezing, heat injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature stress through, soil and crop manipulations. Water deficit 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. Excess water and salt stress, its effects on crop plants and practical ways to overcome these through soil and crop manipulations. Mechanical impedance of soil and its impact on plant growth, measures to overcome soil mechanical impedance. Environmental pollution-air, soil and water pollution, and their effect on crop growth and quality of produce, ways and means to prevent environmental pollution.

Agron. 591 Seminar

Agron. 600 Master's Research

Agron. 700 Ph.D. Research

ENTOMOLOGY

PROGRAMMES

1. M.Sc.

2. Ph.D.

COURSE REQUIREMENTS

M.Sc.

Field of Specialization

Economic Entomology, Insect Ecology, Insect Physiology, Insect Taxonomy, Insect Toxicology

Required Courses

Ent.501, Ent.502, Ent.503, Ent. 504, Ent.505

Supporting Courses

Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem

Minor Fields

Biochemistry, Biotechnology, Chemistry, Nematology, Plant Breeding & Genetics, Plant Pathology or any other as approved by Dean, Postgraduate Studies

Deficiency Courses for students with elective other than Crop Protection

9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization

Economic Entomology, Insect Ecology, Insect Physiology, Insect Taxonomy, Insect Toxicology,

Required Courses

Ent. 601, Ent.602, Ent.603

Supporting Courses

Courses from subject matter fields (other than minor) relating to area of special interest and research problem.

Minor Fields

Biochemistry, Biotechnology, Chemistry, Nematology, Plant Breeding & Genetics, Plant Pathology, or any other as approved by Dean, Postgraduate Studies

Deficiency Courses for students with M.Sc. (Agri.) in a discipline other than Entomology

Ent.501, Ent.502, Ent.503, Ent.504, Ent.505, and other courses as recommended by Student's Advisory Committee

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Ent. 91/PI.Path. 91 Plant Protection-I **2+1** **Sem.I**

(In collaboration with Deptt. of Plant Pathology)

Importance of insects in agriculture; feeding behaviour; identification and losses caused to different crops; methods of insect-pest management; plant diseases; important groups of plant pathogens: their characteristics; symptoms and management; plant clinic; importance and requirements.

Practical: Identification of important agricultural insect-pests and pathogens; familiarization of plant protection equipment; seed treatment and spraying.

Ent. 201 Introductory Entomology **2+1** **Sem. I**

Entomology-definition, importance and scope. Insects-their importance, place and dominance in the animal kingdom. Integument, moulting, body regions and segmentation. Morphology and anatomy of *Ak* grasshopper. Modifications and functions of mouth parts, antennae, legs and wings. Generalized wing venation and wing coupling apparatus. Endoskeleton. Sense organs. Metamorphosis. Types of larvae and pupae. Classification of class Insecta up to sub order level.

Practical: Morphology and anatomy of *Ak* grasshopper. Different types of antennae, mouth parts, legs and wings. Types of larvae and pupae. Study of various insect orders and sub orders. Collection and preservation of insects.

Ent. 204 Fundamentals of Insect Morphology and Systematics **2+1** **Sem. I**

Entomology- definition and its history. Factors for insect abundance. Integument, moulting, body regions and segmentation. Morphology and anatomy of an insect (Grasshopper/Blister beetle). Modification and function of mouth parts, antennae, legs and wings. Wing venation and wing coupling apparatus. Sense organs. Metamorphosis and diapause. Types of reproduction. Taxonomy- its importance, history, development and binomial nomenclature. Definitions of biotype, sub-species, species, genus, family and order. Classification of class Insecta upto orders, suborders and important families with special emphasis on distinguishing morphological characters.

Practical: Collection and preservation of insects including immature stages. Morphology and anatomy of Grasshopper/Blister beetle. Different types of antennae, mouth parts, legs and wings. Wing 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. 205 Insect Ecology and Integrated Pest Management **2+1** **Sem. II**

Insect Ecology- Introduction, environment and its components, effect of abiotic and biotic factors. Biotic potential, environmental resistance and causes for pest outbreaks in agro- ecosystem. Pest surveillance and pest forecasting. Categories of pests. Host plant resistance, cultural, mechanical, physical, legislative and biological control. Chemical control- importance, hazards and limitations. IPM its tools and limitations. Classification, toxicity and formulations of insecticides. Study of important insecticides- botanical, organophosphates, carbamates, synthetic pyrethroids. Novel insecticides, pheromones, nicotiny, chitin synthesis inhibitors, phenyl pyrazoles, avermectins, macrocyclic lactones, oxadiazines, thiourea derivatives, pyridine azomethines, pyroles, etc., rodenticides, acaricides and fumigants. Recent methods of pest control. Insecticides Act 1968. Symptoms of poisoning, first aid and antidotes. Beneficial insects. Important species of pollinators, weed killers and scavengers, their importance. Non insect pests- mites, rodents and birds.

Practical: Study of terrestrial and pond ecosystems, behaviour, orientation, distribution patterns of insects and sampling techniques for the estimation of insect population and damage. Pest surveillance through light and pheromone traps. Practicable IPM practices. Insecticides and their formulations, calculation of doses of insecticides. Compatibility of pesticides. Phytotoxicity of insecticides. IPM case studies.

Identification of common phytophagous mites, rodent, bird pests and their damage. Other beneficial insects - pollinators, weed killers and scavengers.

Ent. 302 Insect Pests of Crops and Stored Grains **2+1** **Sem. I**

Distribution, biology, symptoms of damage and management strategies of insect pests of rice, sorghum, maize, cotton, groundnut, sugarcane, ragi (*Eleusine coracana*), wheat, sunhemp, pulses, castor, safflower, sunflower, mustard, brinjal, bhindi, tomato, cruciferous and cucurbitaceous vegetables, potato, sweet potato, chillies, mango, citrus, grapevine, cashew, banana, pomegranate, guava, sapota, ber, apple, coconut, tobacco, coffee, tea, turmeric, onion, coriander, garlic, ginger, ornamental plants and stored grain insect pests.

Practical: Identification of insect pests, their damage symptoms and management of rice, sorghum, maize, wheat, sugarcane, cotton, pulses, solanaceous, malvaceous, cruciferous and cucurbitaceous vegetables, chilli, mango, citrus, sapota and stored grains.

Ent. 303 Household and Kitchen Garden Entomology **1+1** **Sem. II**

(For students of College of Home Science)

Introduction to insects. Principles and methods of pest control. Safe handling of pesticides. Major pests (including mites, birds and rats) of kitchen garden, household, stored foodstuffs and live-stock, their bionomics and control. Introduction to beekeeping and sericulture.

Practical: Study of insect structures and forms. Identification of important pests and their damage. Pesticides, plant protection equipment and their handling. Familiarization with the beekeeping appliances and handling of bee colonies. Observations on life stages of mulberry silkworm.

Undergraduate Elective/M.Sc. Supporting/Minor Courses

Ent. 433 Apiculture **1+2** **Sem. I**

Indian history of beekeeping. Species and races of honey bees. Morphology and anatomy of honey bee. Colony organization, life cycle and division of labour in *Apis mellifera*. Seasonal management of honey bee colonies; swarming, drifting and curbing drone population. Management of queenless and laying worker colonies. Colony multiplication. Bee enemies and diseases. Protection from pesticidal hazards. Maximizing honey production. Bee flora. Managed bee pollination of crops. Colony migration. Apicultural diversification. Honey and its quality. Economics of beekeeping.

Practical: Important species of honey bees, castes differentiation and body structure. Handling of colonies. Colony organization and food storage pattern. Langstroth hive, apicultural equipment and machinery. Bee flora. Seasonal management practices. Colony division. Mass queen bee rearing techniques. Queen introduction, clipping and marking. Bee pollination of crops. Management of bacterial, viral and fungal diseases of honey bees. Identification and management of parasitic mites, wax moths, ants, wasps and predatory birds. Honey extraction. Pollen, propolis and bee venom collection. Processing of bees wax. Royal jelly production and collection. Honey processing and packaging. Honey testing. Visit to beekeeping industry (Hive manufacturing, equipment manufacturing, honey processing and exporting commercial units).

Ent. 434 Biocontrol and Integrated Pest Management **2+2** **Sem. I**

History and concept of biological control, different groups of biological control agents and biopesticides-macrobials (parasitoids and predators), microbials (bacteria, viruses, fungi, protozoa and nematodes) and botanical- neem, pyrethrum, nicotine, rotenone and others, their use in pest management along with advantages and limitations. Methods of mass production for each of these groups. National and international agencies dealing with biological control. IPM-history, definition and concept. Concept of economic threshold. Pest monitoring and surveillance. Different tools of IPM including physical, mechanical, cultural, biological (parasite and predators, microbial agents), host plant resistance, botanical, chemical, biorationals and biotechnological approaches. Integration of different IPM tactics. Decision making systems. Potential of IPM, its implementation and constraints. Successful example in IPM.

Practical: Identification of important groups of parasitoids, predators and microbial control agents. Laboratory multiplication of parasitoids, predators and microbial control agents. Determination of economic threshold

levels. Demonstration of cultural and mechanical control measures of different pests. Use of pheromones, colour, sticky and light traps for monitoring and surveillance of pests. Study of IPM module in cotton, rice, sugarcane, maize, fruits and vegetables.

Ent. 435 Pesticides and Plant Protection Equipment **2+1** **Sem. I**

Pesticides- classification, properties, entry and mode of action. Formulations and toxicity of pesticides. Factors affecting toxicity of pesticides. Compatibility and synergism. Antidotes. Problems associated with the use of pesticides. Role of repellents, attractants, pheromones, hormones, chemosterilants and antifeedants in pest control. Pest control equipment - history of development, classification, constructional features, principles of working, operation, maintenance and selection. Planning of pest control operations. Practical: Familiarization with different formulations of pesticides, their preparation and use. Toxicity to insects and plants. Calculation of dosages of pesticides and fumigants. Practice in the use of various types of pest-control equipments. Study of factors affecting efficacy of pesticide spray. Calibrations of plant protection equipments. Common troubles in the use of pest-control equipment and their remedies. Estimation of pesticide residue in food commodities.

Postgraduate Courses

Ent. 501 Insect Morphology and Systematics **2+1** **Sem.I**

Evolution of insect body form. Primary and secondary segmentation, structure of typical secondary segment. Different theories regarding segmentation of insect head. Comparative morphological characteristics of insects and their bearing in insect classification. Insect sense organs. Mechanism of flight. Insect Systematics - history and importance. Taxonomic categories. Taxonomic keys. Important rules of Zoological nomenclature. Ethics in taxonomy. Zoogeographical regions of world.

Practical: Comparative study of morphological characteristics of representative type of insects. Collection and preservation of insects and their identification with the help of taxonomic keys. Preparation of taxonomic keys.

Ent. 502 Insect Anatomy and Physiology **2+1** **Sem.I**

Importance and scope of insect anatomy and physiology. Structure and physiology of insect integument. Comparative study of anatomy and physiology of digestive, circulatory, respiratory, excretory, reproductive, nervous, sensory, endocrine and exocrine systems. Embryonic and post-embryonic developments. Diapause. Insect nutrition, inter- and intracellular micro organisms. Artificial diets.

Practical: Study of comparative anatomy of various organ systems of insects through dissection and preparation of mounts of internal organs. Experiments to highlight physiological significance of cuticle, digestive, circulatory, respiratory, excretory, endocrine and exocrine systems. Formulation and preparation of artificial diets for rearing of insects.

Ent. 503 Classification of Insects **2+1** **Sem. I**

History of insect classification and its importance. Introduction to phylogeny of insects. Classification of Superclass Hexapoda including all the classes with special emphasis on Class Insecta. Distinguishing morphological characters alongwith the habits and habitats of insects belonging to economically important families of all the orders of Class Insecta.

Practical: Collection and preservation of insects. Identification of insects upto family level. Field visits to collect insects of different orders.

Ent. 504 Insect Ecology **2+1** **Sem.II**

Basic concepts of ecology. Organization levels. Ecosystem concept. Food chain. Characteristics of insect populations. Physical environment, its influence on abundance, distribution, rate of increase and diapause in insects. Concept of intrinsic rate of increase. Biotic factors, intraspecific competition, logistic theory. Interspecific relationships, prey/predator models, effect of food and space on insects. Natural balance, population dynamics and regulation. Defense mechanisms against predators/parasitoids. Estimation of dispersal, migration and mortality factors. Life-tables and their application. Systems approach to ecology. Abundance and diversity of insects, its causes and estimates. Pest outbreaks and forecasting. Sampling considerations for population estimates of insects in different habitats. Pest management as applied ecology.

Practical: Measurement of microenvironment- maintenance of physical factors, calculation of rate of increase (rm), stable age distribution and fitting of logistic curve for population growth. Determination of distribution pattern, and size and number of samples. Estimation of population of different groups of insect pests. Measurement of insect diversity. Life-tables for determining mortality factors.

Ent. 505 Toxicology of Insecticides

2+1

Sem. II

Definition, importance, scope, basic principle of insecticide toxicology and its relationship with other disciplines. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, neonicotinoids, oxadiazines, phenylpyrozoles, botanicals and new promising compounds etc. Criteria, methods, problems and solutions of bioassay. Evaluation of insecticide toxicity, joint action of insecticides, synergism, potentiation and antagonism, factors affecting toxicity of insecticides, selectivity and phytotoxicity. Insecticide metabolism, pest resistance to insecticides, mechanisms and types of resistance, insecticide resistance management and pest resurgence. Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides, safe use of insecticides, diagnosis and treatment of insecticide poisoning.

Practical: Insecticide formulation and mixtures, quality control of pesticide formulations. Working out doses and concentrations of pesticides for laboratory and field evaluation for their bioefficacy, bioassay techniques, probit analysis, evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Preparation of working standard solutions of pesticides, Sampling, extraction, clean-up and estimation of insecticide residues by various methods, calculations and interpretation of data, visit to toxicology laboratories, good laboratory practices.

Ent. 506 Biological Control of Insect Pests

2+1

Sem. I

Principles and scope of biological control. Techniques in biological control. Biology and host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogens and their mode of action. Biological control of weeds using insects. Techniques for mass production of quality biocontrol agents. Various formulations and economics of bioagents. Field application and evaluation. Analysis of successful biological control projects. Trends and future possibilities of biological control. Importation of natural enemies and quarantine regulations. Biotechnology in biological control. Semiochemicals in biological control

Practical: Identification of common natural enemies of crop pests and weed killers. Techniques for rearing of natural enemies. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of natural enemies of crop pests and weeds and their laboratory hosts. Field collection of parasitoids and predators. Hands-on training in culturing and identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Ent. 507 Plant Resistance to Insects

2+1

Sem. II

History and importance of host plant resistance. Principles, classification, components, types and mechanisms of resistance. Insect-host plant relationships. Theories and bases of host-plant selection. Chemical ecology. Tritrophic relations. Volatiles and secondary plant substances. Basis of resistance. Factors affecting plant resistance including biotypes and measures to combat them. Screening techniques. Breeding for insect resistance in crop plants. Exploitation of wild plant species and gene transfer. Successful examples of resistant crop varieties in India and world. 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. Demonstration of antibiosis, tolerance and antixenosis.

Ent. 508 Integrated Pest Management

2+1

Sem. I

History and origin. Definition and evolution of various related terminologies. Concept and philosophy of IPM. Ecological principles. Determination of crop losses and economic thresholds. Integration of different pest management methods. 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 and cost-benefit ratios. Case studies of successful IPM programmes. National and international set-ups for integrated pest management.

Practical: Characterization of agro-ecosystems. Sampling methods and factors affecting sampling. Population estimation methods. Crop loss assessments, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL. Crop modelling, designing and implementing IPM system.

Ent. 509/PI.Path.509/Nem. 509 Molecular Approaches in Plant Protection 2+1 Sem.II

Recent concepts of molecular biology and techniques used in plant protection. Genes of interest in plant protection. Identification, characterization and isolation of novel genes involved in pest resistance. Molecular bases of host plant-insect and pathogen interactions. PR-proteins and G-proteins. Molecular characterization of biodiversity-insects and pathogens. Molecular biology of baculoviruses. Molecular mechanisms of genetically engineered plants for pest resistance and pesticide resistance. Improvement of biocontrol agents and useful insects using molecular techniques. Bio-safety related issues.

Practical: Molecular characterization of pest populations. Detection of biotypes/races. Establishment of phylogenetic relationships/dendrograms. Detection of Cry-gene and estimation of cry-toxin; characterization of capsid proteins of insect viruses. Detection of disease induced biochemical changes at molecular level.

Ent.510/PI.Path.510/ Nem. 510 Quarantine in Plant Protection 2+0 Sem.II

Definition of pest and pesticides and transgenics as per Govt. notification. Relative importance and quarantine for domestic and international. Quarantine restrictions in the movement of agricultural produce including seeds and planting material. Case histories of exotic pests and diseases and their status. Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations. PQ Order 2003. Environmental Acts and APEDA. Industrial registration. Import and Export of bio-control agents. Special requirements for biopesticide registration. Identification of pest and disease free areas. Contamination of food with toxigens of micro-organisms and their elimination.

Symptomatic diagnosis and other techniques to detect pest/pathogen infestations. Vapor Heat Treatment (VHT) and other safer techniques of disinfestations and salvaging of infected material. WTO regulations. Non-tariff barriers. Pest risk analysis and good laboratory practices for pesticide laboratories. Pesticide industry. Sanitary and phytosanitary measures.

Ent.511 Insect Vectors of Plant Pathogens 2+1 Sem.II

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. Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors. Transmission of plant viruses by insect vectors and mites. Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers. Epidemiology and management of insect transmitted diseases through vector management. Paratransgenesis.

Practical : Identification of common vectors of plant pathogens- culturing and handling of vectors. Demonstration of virus transmission through vectors. Vector virus relationship studies.

Ent. 512 Commercial Entomology 2+1 Sem.II

Development of apiculture. Classification of bees and distribution of genus Apis. Morphological adaptations. Behaviour and activities of honey bees. Honey bee nutrition. Artificial queen bee rearing and bee breeding. Sex and caste determination. Honey bee ecology. Bee pheromones. Pests and diseases of honey bees. Bee poisoning. Hive products. Planned crop pollination using bees. Silkworm species and their characteristics. Moriculture. Silk seed production. Rearing and management of silkworms. Pests and diseases of silkworms. Silk and its uses. Lac insect's management. Economic importance of insect-pests of human health and habitation. Biology, damage and management strategies for mosquitoes, house flies, bed bugs, ants, termites, cockroaches and wasps.

Practical: Morphological adaptations in different castes of honey bees. Recording of colony data. Selection and breeding of honey bees. Latest techniques in mass queen bee rearing. Artificial diets and feeding. Production and extraction of hive products. Preparation of beekeeping projects. Recording pollination behaviour and determining pollination requirements. Identification of different species of silkworms. Silkworm rearing equipment. Silkworm rearing and management. Diseases of silkworms. Lac insect and host management. Lac collection and processing. Management of insect-pests of public health importance and human dwellings.

- Ent. 513 Storage Entomology** **2+1** **Sem. II**
 Introduction, history and concepts of storage entomology. Post-harvest losses. Factors responsible for grain losses. Important pests namely insects, mites, rodents, birds and micro-organisms associated with stored grains and agricultural products. Association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage. Sources of infestation. Type of losses in stored grains and their effect on quality including biochemical changes. Ecology of insect pests of stored commodities. Stored grain deterioration process. Type of storage structures. Ideal storage conditions. Management of rodent and bird pests. Preventive and curative measures for the management of insect pests of stored grains. Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.
 Practical: Collection and identification of stored grains insect pests and their nature of damage. Detection of insect infestation in stored food grains and estimation of stored losses. Determination of micro flora of grains. Determination of grain moisture. Familiarization of storage structures. Laboratory culturing of stored grain pests. Demonstration of preventive and curative measures including fumigation techniques. Field visits to grain markets, central and FCI warehouses, IGSMRI and commercial silos.
- Ent. 514 General Acarology** **1+1** **Sem. II**
 History of acarology. Importance of mites and ticks as a group. Introduction to morphology and biology of mites and ticks. Broad classification of major orders and important families of Acari including diagnostic characteristics. Economic importance of mites. Seasonal occurrence and nature of damage of mite pests on different crops. Mite pests in polyhouses, stored products and honey bees. Management of mites using acaricides and natural enemies. Culturing of phytophagous, predatory and parasitic mites.
 Practical: Collection and extraction of mites from different habitats. 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. 601 Advanced Insect Systematics** **2+0** **Sem. II**
 Study of International Code of Zoological Nomenclature in detail. Phylogenetics and Classification. Development of cladograms. Molecular approaches for the classification of organisms. Homology. Species concepts and speciation processes and evidences. Zoogeography. Study of different views on the evolution of insects. Fossil insects and evolution of insect diversity over geological times. Concept of Phylocode and alternative naming systems for animals. Molecular Taxonomy. Barcoding species. Websites related to insect taxonomy and databases.
- Ent. 602 Advanced Insect Physiology** **2+0** **Sem. II**
 Physiology and biochemistry of insect cuticle and moulting process. Advances in physiology of digestive, circulatory, respiratory, excretory, reproductive, nervous and sensory organ systems of insects. Source, chemistry and physiology of insect hormones as regards their growth and development. Biosynthesis of chitin and physiology of chitin synthesis inhibitors. Biochemistry and mode of action of behaviour modifying compounds. Nutrients and their physiological influences in insects. Defence mechanisms in plants against insects.
- Ent. 603 Advanced Insect Pest Management** **2+0** **Sem. II**
 Database management and computer programming, simulation techniques and system analysis and modelling. Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests. Advances in application of behavior modifying chemicals, insect growth regulators, genetic engineering and other biotechnological strategies for management of insect pests. Strategies for pesticide resistance management and resurgence in insects. Scope and limitations of bio-intensive and ecological based IPM programmes. Applications of IPM to farmers' real time situations. Dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation. Advances in pesticide application technology.
- Ent. 604 Advanced Insect Ecology** **2+0** **Sem. I**
 Influence of changing environment and pest populations. Life-system approach to the study of insect

populations, case studies. Key factors in population dynamics and their manipulation. Numerical changes in insect population, causes and estimation. Modes of insect-plant interactions, tritrophic interactions. Evolution of diversity, diversity indices, biodiversity and conservation. Foraging ecology. Reproductive ecology. Disruption of diversity and stability of insect species due to pesticide application. Predictive models and forecasting of pest outbreaks. Systems ecology, modelling. Sequential sampling. Characteristics of distribution of insects- indices of dispersion, Taylor's power law. Ecological aspects of pest management.

Ent.605 Advanced Biological Control **2+0** **Sem.II**

(Pre-requisite Ent.506)

Effect of abiotic and biotic factors on natural enemies of crop pests. Nutrition of entomophagous insects and their hosts. Dynamics of biocontrol agents vis-à-vis target pest populations. Insectary facilities and equipments. Basic standards of insectary and viable mass-production unit. Colonization of natural enemies. Techniques for release of natural enemies and their recovery. Evaluation of effectiveness of natural enemies. Importance of biotypes in biological control. Survivorship analysis and ecological manipulations. Modification of chemical control practices to preserve natural enemies. Scope of genetically engineered microbes and parasitoids in biological control. Genetics of ideal traits in biocontrol agents for introgressing and for progeny selections. Breeding techniques of biocontrol agents

Ent. 606 Advanced Insecticide Toxicology **2+1** **Sem. I**

Penetration, binding and distribution of insecticides in insect systems, insecticide selectivity, biochemical and physiological basis of selectivity, toxicodynamics of insecticides. Biochemical and physiological target sites of insecticides in insects, developments in biorationals, biopesticides and newer molecules, their modes of action and structural - activity relationships, metabolism of insecticides. Joint action of insecticides, activation, synergism and potentiation. Pesticide resistance- mechanisms and resistant management strategies. Contribution of genetics to resistance, monogenic and polygenic resistance. Bound and conjugated residues, persistence and pollution, health hazards and other side effects of insecticides. Analysis of insecticidal residues - sampling, extraction, clean-up and estimation by various methods, maximum residue limits (MRLs) and their fixation. Insecticide laws and standards.

Practical: Sampling, extraction, clean-up and estimation of insecticide residues by various methods, calculations and interpretation of data, biochemical and biological techniques for detection on insecticides resistance in insects.

Ent. 607 Advanced Host Plant Resistance **2+0** **Sem.II**

(Pre-requisite Ent.507)

Insect herbivory and plant defense. Genes for plant defense against herbivory. Factors affecting expression of genes. Constitutive and inductive resistance. Biochemistry of induction of resistance. Biotechnological approaches in host plant resistance- genetic manipulations and incorporation of resistant gene(s) in crop varieties. Genetics of host plant resistance. Inheritance of resistance and its estimation Techniques and determination of categories of plant resistance. Breakdown of resistance in crop varieties.

Ent. 608 Insect Behaviour **2+0** **Sem. II**

Evolution and inheritance of insect behaviour. Innate and learned behaviour patterns. Orientation - forms of primary and secondary orientation including taxes and kinesis. Responses to environmental stimuli; role of visual, olfactory and auditory signals. Biological functions of insect behaviour such as locomotion, feeding, host selection and location, escape, defense, reproduction, dispersal and migration. Activity rhythms and biological clocks. Genetic and hormonal control of insect behaviour. Regulation of insect population through behavioural manipulations. Inter- and intra-specific communication. Insect societies. Nest founding and construction, brood care, defense and caste determination in social insects.

Ent.591 Seminar

Ent. 600 Master's Research

Ent.700 Ph.D. Research

EXTENSION EDUCATION

PROGRAMMES

1. M.Sc.
2. Ph.D.
3. B.Ed.

COURSE REQUIREMENTS

M.Sc.

Field of Specialization

Communication and Adoption of Innovations, Farmers' Training and Education, Extension Administration.

Required Courses:

Ext.501, Ext.502, Ext.503, Ext.504, Ext.505, Ext.506

Supporting Courses:

Stat.421, Stat.522, PGS 501 and other courses from subject- matter fields (other than minor) relating to area of special interest and research problem.

Minor Fields:

Any agricultural subject depending upon the student's interest and research problem.

Deficiency courses for students with elective other than Agri-Business Management, Economics and Extension Education

9-12 credit hours of atleast 400 series 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 and Education, Extension Administration.

Required Courses

Ext.601, Ext.602, Ext.603

Supporting Courses

Stat.526 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem.

Minor Fields

Any agricultural subject depending upon the student's interest and research problem.

Deficiency courses for students with M.Sc. (Agri.) in a discipline other than Extension Education.

Ext.501, Ext.502, Ext.503, Ext.504, Ext.505, Ext.506, Stat.522 and other courses as recommended by Student's Advisory Committee.

B.Ed.

Compulsory courses

Edu.451, Edu.452, Edu.453, Edu.454, Edu.455, Edu.456, Edu.457, Edu.458, Edu.459, Edu.460

Choice courses

- i) Teaching subjects (one out of three streams to be chosen by each student)

STREAMS

- (i) Agriculture
- (ii) Agromechanics
- (iii) Home Science
- (iv) Fashion Designing

1st Sem.

- Edu.461
Edu.464
Edu.465
Edu.465

2nd Sem.

- Edu.462 /463
Edu.467
Edu.466
Edu.472

- ii) Area of special interest (one out of two areas to be chosen by each student)

AREAS

- (i) Vocational Guidance and Counseling
- (ii) Curriculum and Text Books Development

- Edu.468
Edu.470

- Edu.469
Edu.471

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

- Ext. 91 Extension - I** **2+0** **Sem.II**
Introduction; meaning and importance of rural development, its basic objectives. Integrated Rural Development Programme, its working, objectives and achievements. Various schemes of IRDP for strengthening the infrastructural base in the villages. Role of community development and voluntary agencies in rural development. Role of Panchayati Raj Institutions in agriculture and rural development. Past strategies and current approaches to rural development.
- Ext.101 Dimensions of Agricultural Extension** **1+1** **Sem.II**
Education - meaning and types. Extension Education and Agricultural Extension - meaning, objectives, principles and philosophy. Importance and problems of rural development. Agricultural and rural development programmes of pre and post independence era. Powers, functions and organizational set-up of three tier Panchayati Raj System. New trends in extension education and privatization of extension. Women development programmes. Emergence of broad based extension.
Practical: Visit to Village Farmer's Club, Cooperative Agricultural Service Society, Panchayati Raj Institutions, District Rural Development Agency, Self Help Groups and Voluntary Organizations. Identification of the agricultural problems using Participatory Rural Appraisal Techniques.
- Ext.201 Fundamentals of Rural Sociology and Educational Psychology** **2+0** **Sem.I**
Introduction and importance of rural sociology in agricultural extension. Indian rural society. Social groups. Factors in formation and organization of groups. Motivation in group formation and role of social groups in agricultural extension. Social stratification. Class, caste system, culture, customs, folkways, mores, taboos, rituals, traditions, social values and attitudes - meaning and role in agricultural extension. Functions and role of social institutions. Social organizations. Social control, social change and their factors. Leadership, different methods of identification of leaders and their training. Scope and importance of educational psychology. Intelligence and personality. Teaching- learning process. Principles of learning and their implications for teaching.
- Ext.202 Extension Methodologies and Communication Skills for Transfer of Technology** **1+1** **Sem. I & II**
Meaning, nature, importance, elements, models and barriers in communication. Extension programme planning. Principles and steps in programme development process. Monitoring and evaluation of extension programmes. Extension teaching methods and factors influencing their selection and use. Combination (Media Mix) of teaching methods. Innovative information sources. Audio - visual aids; election, preparation, use and evaluation. Meaning, scope and importance of agricultural journalism. Diffusion and adoption of innovations. Models of adoption process. Factors influencing adoption process. Capacity building of extension personnel and farmers. Communication skills for effective transfer of technology. Organizing seminars and conferences.
Practical : Simulated exercises on communication. Developing a project based on identified problems in a selected village. Organization of group discussion and method demonstration. Visit to Krishi Vigyan Kendra. Planning and script writing for radio and television talks. Planning and preparation of visual aids and agricultural information materials. Handling of public address system.
- Ext. 302 Communication Skills** **0+2** **Sem.II**
Development of oral communication skills for individual, group and mass contact under simulated and real life conditions. Developing good listening skills and practice in delivering radio and TV talks under simulated conditions. Practice in writing popular farm literature- articles, leaflets, bulletins, folders, newspapers and news stories etc. Practice in identification and use of traditional communication media.
Undergraduate Elective/M.Sc. Supporting/Minor Courses

Ext.433 Visual and Graphic Communication **1+1** **Sem.I**

Definition, characteristics, classification, principles and role of visuals in communication. Contribution of visual perception in learning process. Planning, preparation, presentation and evaluation of visual aids, low cost visuals, photographs and pictures. Computer based digitized visual materials. Use of drawing techniques for visuals. Selection and use of animation tools in transfer of technology. Preparation and use of resource map for extension work. Designing of visuals for print and electronic media. Scope and importance of journalism in agriculture.

Practical: Preparation and use of visual aids. Generating computer aided presentation of graphics. Scanning of visuals, image editing and script writing for radio & TV. Developing agricultural video films. Visit to animation, print and electronic media centers. Writing of news items, articles, success stories etc. for print and electronic media. Presentation and evaluation of visuals.

Ext.434 Communication and Information Technology **2+1** **Sem.I**

Introduction to communication. Problems in communication and feedback. Role of information and communication technology in agriculture and rural development. Extension teaching methods and their use. Trends in agriculture information management system. Need and scope of cyber extension. Importance of kiosks, agri-portal, internet café, community and FM radio in villages. Privatization of cyber extension. Public-private partnership. Development of Information Communication Technology (ICT) in changing the agricultural scenario.

Practical: Studying problems faced by farmers at Agri-clinic and analyzing communication problems of extension personnel. Use of different extension teaching methods in field and simulated conditions. Practice in planning and conducting video-conferencing. Visit to information kiosks. Identifying problems in agriculture information management system.

Ext.435 Behavioural Skills for Human Resource Development **2+0** **Sem.I**

Concept of human behaviour. Taxonomy of behavioural domains. Human needs and their hierarchy. Attitude, its characteristics and measurement. Perception and its principles, selectivity in perception. Motivational skills for attitudinal and perceptual changes. Problem-solving skills. Innovativeness in human behaviour, response and resistance to change. Concept of self, Johari's window model. Defence mechanism. Group dynamics. Group behaviour and conflict management. Decision-making process. Theories of leadership. Concept of human resource development and human relations. Human interaction, its importance and types. Interpersonal perception and social behaviour.

RAWE 499 Rural Agricultural Work Experience **0+20** **Sem. II**

After the completion of course work, the students of B.Sc. Agri. (Hons.) will receive training under the compulsory RAWA programme for 20 weeks. The students will attend the one day orientation each in electives: (a) Soils, Agronomy and Agro-forestry; (b) Crop Protection and Economics Agri-business and Extension Management. (c) Horticulture; (d) Plant Breeding, Genetics and Biotechnology; and (e) Post Harvest Technology and Value Addition. The students will attend two weeks Village Attachment Training. Further, they will undergo 12 weeks on-campus training in: (a) Bee-keeping; (b) Mushroom cultivation; (c) Plant Clinic Activities of Farmers' Service Centre, Communication Centre and Kairon Kisan Ghar; (d) Seed/Nursery Production; (e) Food Processing & Preservation; and (f) Biotechnological Tools in Crop Improvement. Students will also attend 4-week off-campus training in different elective-wise activities. During the last week of the training, the students will submit the report whose evaluation will be done by the concerned teachers on the basis of their performance in orientation, village attachment, on and off-campus training.

Postgraduate Courses

Ext. 501 Development Perspectives of Extension Education **1+1** **Sem.I**

Objectives, principles and philosophy of extension education. Adult education and distance education. Pioneering extension efforts and their implications in Indian agricultural extension system. Analysis

of extension systems of ICAR, SAU, State departments and non-government organizations. Poverty alleviation, employment generation and women development programmes. Problems in rural development. Decentralised decision making, bottom-up planning. Farming system approach. Farming situation based extension. Market led extension. Farm field school. Agricultural Technology Information Centre. Kisan Call Centres, National Agricultural Innovation Project.

Practical: Studying on-going rural development programmes. Visits to KVK, NGO and extension centers of State Agricultural University and state development departments to study their objectives, organizational set up and activities. Report preparation and presentation.

Ext. 502/HECM 502 Development Communication and Information Management 2+1 Sem.II

Communication-concept, meaning, importance, models, theories and types. Communication delity, credibility, empathy, feedback and factors affecting communication process. Communication skills. Characteristics and role of key communicators in development. Expert system in selected enterprises. Role of ICT in communication. Social networks and development. Effective oral communication, public speaking, non-verbal communication, writing skills and soft skills. Participative communication-meaning, importance, process and determinants. Development communication-concept, nature and significance. Recent advances in communication- print and electronic, internet, e-mail, fax, mobile, interactive video and teleconferencing, computer and computer networking (PAN, LAN, CAN, MAN, WAN), AGRINET, e- Governance.

Practical: Exercises in oral and written communication. Planning and use of different communication approaches. Practical hands on experience in recent advances in print and electronic media.

Ext.503/HECM 503 Participatory Programme Management 1+1 Sem.II

Conceptual framework of extension programme. Planning - key concepts and importance in planned change. Participatory planning - concept, importance, process. Techniques of participatory planning- RRA, PRA and PLA and their application in extension. Approaches of participatory planning - cooperative, democratic, bottom up and down. Project management techniques - PERT, CPM, SWOT analysis, obtaining technical and monetary support from GOs and NGOs. Importance and ways of people's participation in programme planning. Concept and formation of farmers and women SHGs. Implementation and evaluation - concept, importance and techniques.

Practical: Application of PRA methods. Critical review of evaluation studies related with farmers, women and rural development programmes. Critical analysis of monitoring and evaluation of developmental programmes. Preparation and implementation of home improvement / agriculture development work plans. Critical evaluation of work plans with specific evaluation techniques. Organizing and evaluating programmes related to farmers, women and children at village level.

Ext. 504 Diffusion and Adoption of Innovations 1+1 Sem.I

Concept and elements of diffusion, innovation generation and development process in application of research. Concept and stages of adoption and innovation-decision process. Innovativeness, adopter categories and their characteristics. Attributes of an innovation and factors influencing the rate of adoption. Concept of over adoption. Role of change agents in diffusion and adoption. Meaning, characteristics and types of opinion leaders. Multi-step flow of innovation. Concepts of homophily, heterophily and their influence on flow of innovations. Types and consequences of innovation-decisions. Meaning, theories, process, steps and factors influencing decision making.

Practical: Case studies in individual and community adoption process. Content analysis of adoption studies. Identification of adopter categories of a selected technology. Studying attributes of current farm technologies. Identification of opinion leaders. Sources of information at different stages of adoption. Studying factors affecting rate of adoption. Presentation of reports on adoption and diffusion of innovations.

Ext.505/Econ.506/Soc.506/HECM 501 Research Methodology for Social Sciences 2+1 Sem.I

Importance and scope of research in social sciences. Concept and characteristics of social research. Types of research. Fundamental vs Applied. Concept of researchable problem - research rioritization,

research process. Hypothesis-meaning, characteristics, types and testing. Review of literature. Development of theoretical orientation of the research problem. Concept, construct, variables and their measurement. Sampling design, sampling error and methods of sampling. Research design and techniques. Types of data collection tools and testing their reliability and validity. Scaling techniques. Coding, editing, tabulation and validation of data. Tools of data analysis. Statistical package for social sciences, interpretation of results, writing research report / thesis. Writing of articles. Universal procedures for preparation of bibliography.

Practical: Selection and formulation of research problem, objectives and hypothesis. Selection of variables and their operationalisation. Developing conceptual framework of research. Development of data collection tools and measuring their validity and reliability. Data processing, tabulation and analysis. Formulation of secondary tables. Writing of thesis and research articles. Presentation of reports.

Ext. 506 Human Resource Development 2+1 Sem.II

Importance and scope of human resource development (HRD). Inter disciplinary approach, functions, systems and case studies in HRD. Different experiences of HRD interventions. Social and organizational culture. Organizational and managerial values and ethics. Motivation and productivity. Collective bargaining and negotiation skills for human resource management. Information management and measurement. Inter and intra personal processes. Stress and coping mechanisms. Organizational communication. Team building process. Human resource development and supervision. Tasks and responsibilities of a professional manager. Skills required for extension workers. Decision making, management by objectives, behavioural dynamics, leadership styles, group dynamics. Types, models, methods and evaluation of training. Determining training needs and development strategies. Facilities for trainers training and techniques for trainees participation. Research studies in training extension personnel. Main issues and emerging trends in human resource development, culture and climate.

Practical: Visits to different training organizations to review their on going activities and facilities. Analysis of training methods used for imparting training to farmers and extension personnel. Evaluation of a training programme. Studying human resource development in an organization in terms of performance, organizational development, employee's welfare and improving quality of work life and human resource information.

Ext.507 Entrepreneurship Development and Management in Extension 2+1 Sem.II

Agri-entrepreneurship. Traits and types of entrepreneurs. Establishing an enterprise, project management and appraisal. Profitable micro agri-enterprises in India. Agro processing, Khadi and Village Industries Commission. Sources of micro finance. Marketing for enterprises. Gender issues in entrepreneurship development. Nature, importance, approaches and levels of management. Extension management. Making planning effective. Decision-making process. Principles and elements of an organization. Interpersonal relations in the organization. Training and development. Methods of performance appraisal. Functions and approaches to leadership. Leadership styles. Organizational communication. Work motivation and performance. Approaches to motivation. Qualities, functions and essentials of effective supervision. Nature, process, types and techniques of managerial control, budgeting, observation, PERT, CPM and MIS.

Practical: Field visits to successful enterprises, financial institutions and extension organizations. Studying characteristics of successful entrepreneurs. Development of project proposal. Case studies of successful/failed enterprises. Exercises on market survey. Simulated exercises to understand management process. Techniques of decision making and designing organizational structure. Group activity on leadership development skills. Development of short and long term plans.

Ext.508 Perspectives of Distance Education 2+0 Sem.I

Concept, evolution, philosophy, work ethics and characteristics of distance education. Theory, methodology, epistemology, dimensions, scope and problems of distance education. Scope of non-formal, continuing and correspondence education. Forms and systems of distance and open education. Methods and modes of teaching and learning in distance education. Systems approach, course planning, target groups and barriers to learning in distance education. Planning and management of network learning. Application of

information and educational technologies in distance education. Development of course, course material and management of resources. Video classroom strategy in distance education. Strategies for maximizing services to students and programme evaluation.

Ext. 509 Market Led Extension Management **1+1** **Sem.II**

(In collaboration with Deptt. of Economics and Sociology, COBSc.&H)

Present scenario of agricultural extension at the national level. Emerging perspectives, challenges and dimensions of market led extension. An overview of agricultural marketing. Consumer behaviour, marketing communication and promotional strategies. Marketing research process. Agricultural trade liberalization and its impact. International marketing opportunities. Implications of Agreement on Agriculture, TRIPS and Intellectual Property Rights. Role of self help groups and public private linkages in market led extension. Information technology enabled approaches for market led extension and communication.

Practical: Identification and analysis of different marketing sources for agricultural commodities. Developing strategy for an effective market intelligence system and marketing plan to suit rural situation. Visits to APEEDA and Apni Mandi to study their processes and procedures related to market-led extension.

Ext. 510 Visual Communication **1+1** **Sem.I**

Role, characteristics and functions of visuals and graphics in communication. Theories of visual perception. Classification and selection of visuals. Designing message for visuals, graphic formats and devices. Presentation of scientific data. Principles and production of low cost visuals. Photographs, reprographic and computer based visuals. Digitized video material in multimedia production. Designing visuals for print, TV and video. Scanning, pre-testing and evaluation of visuals.

Practical: Preparation of low cost projected and non-projected visuals. Designing and layout of charts, posters, flash cards, power point presentations. Generating computer aided presentation graphics. Scanning and evaluation of visuals.

Ext.511 / HECM 506 Gender Sensitization for Empowerment **2+0** **Sem.I**

Gender sensitization-meaning, need and importance of empowering women. Gender in community diversity and its implication for empowerment. Gender perspectives in development of women, social characteristics, desegregated roles, responsibilities, resources, constraints and opportunities. Economical, educational and anthropological parameters in gender perspectives. Gender dimensions and methodologies for empowerment. Gender analysis framework-context, activities, resources, tools and programme action profile. Training aids for gender sensitization. Empowerment through gender specific technologies, household technology interface. Socio-cultural interface and women as consumer of technologies. Gender issues and development-health and nutrition, violence, governance, educational media.

Ext. 601 Advances in Agricultural Extension **2+0** **Sem.II**

A critical analysis of different agricultural extension approaches. Importance, relevance, identification and documentation of indigenous knowledge system and its integration in research formulation. Concept of agricultural knowledge and information system and training of stakeholders. Concept of cyber extension. Alternative methods of financing agricultural extension. Importance, scope, implications of Research-Extension - Farmer - Market linkage. Market - led extension. Farmer - led extension. Farm field school. Public - private partnership in extension. Stakeholder's analysis in extension. Gender issues in extension. Implications of WTO and AOA for extension services. Re-orientation of extension services for agri-business and marketing activities. Govt. organisations / institutes / non-govt. organizations collaboration to improve efficiency of extension. Issues related to rural poverty and privatization of extension. Intellectual property rights. Extension reforms in India. Organization innovations in extension. Agricultural technology information centre. Institutional village linkage programme. Kisan call centres.

Ext. 602/HECM 602 Scaling Techniques for Behavioural Research **2+1** **Sem.II**

Meaning, types, principles and steps of scaling. Techniques of attitude scale construction - Paired comparison, Equal appearing intervals, Successive intervals, Summated ratings, Scalogram

analysis, Scale discrimination technique, Sociometrics, Q-sort technique, Semantic differential technique, Projective and Semi projective techniques, Critical incident technique. Reliability and Validity of Scales. Knowledge measurement. Participatory tools and techniques in behavioural research. Data collection and evaluation. Impact analysis. The e-data collection and information analysis. Use of computer in analysis of data.

Practical: Practice in construction of different scales and their use under various situations. Testing reliability and validity of constructed scales. Application of semi projective and projective techniques. Practicing participatory tools and techniques. Preparation of data collection instruments. Use of e-data collection methods. Review of previous studies.

Ext.603 Advances in Training Technology **3+0** **Sem.I**

Paradigm shift in training and learning scenario. Training need assessment, approaches, designs and models. Designing an effective training programme and training session. Harmonizing training needs, course objectives, content and methods. Designing experiential training sessions, simulation exercises and openness in training transaction, managing dilemmas, ambivalence, conflicts and confusion for trainers and trainees. Recent training techniques for understanding and facilitation of team building. Group dynamics, motivation and empowerment. Laboratory methods, micro-lab process work and sensitivity training. Thematic Appreciation Test, inventories, cases as training tools. Participatory training techniques. Trainer's roles and competencies. Factors affecting training effectiveness. Monitoring, evaluation and follow-up of training.

Ext.604 Organizational Development **2+0** **Sem.II**

Concept, characteristics, types and levels of organization. Human relations and organizational behaviour. Theories of organization. Systems approach to study organization needs. Motives, attitude, values and ethical behaviour, alienation and work, work motivation, communication and interpersonal behaviour, organizational communication, leadership behaviour, group behaviour, decision-making, problem solving techniques. Organizational climate and structure. Dimensions of motivational climate. Elements and principles of organizational management. Organisational culture and performance. Management by objectives. Transactional analysis. Stress management. Conflict management. Expert system. Forecasting techniques - time series analysis and delphi. Management information system.

Ext.605 Advanced Instructional Technology **2+0** **Sem.I**

Scope of instructional technology. Guidelines for curriculum development in agricultural universities. Development of course outlines, lesson plans for theory and practicals. Teaching and learning styles. Theories of learning. Taxonomy of educational objectives. Instructional course objectives. Motivation of students. Instructional methods. Experiential learning cycle. Innovative instructional aids. Identification of innovative low cost instructional aids. Computer assisted instruction (CAI). Preparation of lesson plans for theory and practical with CAI design. Programmed instruction technique. Team teaching. e - Learning. Art of effective communication. Distance education. Student evaluation and question bank. Parameters for appraisal of teacher performance. Review of research in instructional technology.

Ext.606 Theory Construction in Social Sciences **2+0** **Sem.I**

Meaning, elements, ideal criteria, functions and types of theory. Importance of theory construction in social sciences. Meaning, types and rules of definitions. Meaning and classification of generalizations. Meaning and types of relationships. Terminologies used in theory construction. Steps in theory building. Axiomatic techniques and historical approaches. Scientific application of theoretical concept in social sciences. Applying appropriate statistical tests for testing of theory.

Ext.607 Transfer of Technology in Agriculture **2+0** **Sem.II**

Transfer of technology (TOT) and transfer of technology systems. Knowledge generating system. Knowledge disseminating and consuming system. Input supplying agencies system. Appropriateness of communication media in the system of technology transfer. New communication strategy for transfer and adoption of agricultural technology. Extension training in transfer of technology.

Analysis of constraints in transfer of technology. Agencies or departments involved in TOT. Role of extension professionals in TOT. Attributes of technology in relation to TOT process. TOT to resource poor farmers. Role of key communicators or local leaders in TOT. Private and public partnership in TOT. TOT system in USA, Asian and European countries.

Ext.608/HECM 606 Advanced Media Management **2+1** **Sem.I**

(In collaboration with Deptt. of Agril. Journalism, Languages & Culture, COBSc.&H)

Principles of management - managing the media organization, managerial functions in the media organization, introduction to media organization. History, functions, uses and theories of media. Editorial and circulation management, need and importance, marketing concept/circulation, affecting factors, circulation manager, functions of circulation department, difficulties in circulation, promoting circulation. Need and concept of personnel management - role of personnel management, integration of interests, functions, human resource planning. Advertising management. Financial management- importance of finance, financial problems, production and printing management. Significant issues in the management of broadcast media-organizational structure of radio and television in public and private sectors. Concept, history and role of FM radio, community radio and TV in transfer of technology. Functions of various departments and personnel - production, marketing, financial, managing the station/channel.

Practical: Visit to print, electronic and new media organizations to understand the designing, media development, organizational management, functions, problems etc.

Ext.591 Seminar

Ext.600 Master's Research

Ext.700 Ph.D. Research

B.Ed. Courses

Edu.451 Structure of Modern Indian Education **3+0** **Sem.II**

Structure, problems and future trends of modern Indian Education with special reference to pre -school, primary, secondary, higher education and teachers' training. Various educational acts and reports of educational commissions since independence. Orientation towards vocationalization and correspondence education.

Edu.452 Philosophy and Sociology of Education **3+0** **Sem.I**

Meaning and scope of education. Changing aims of education. Educational philosophies of Plato, Rousseau, Dewey, Tagore, Gandhi, Paulo Freire and Ivan Illich. Education from sociological and economic points of view. School and social change. Family as an educational institution. Pattern of education for a democratic and socialist society.

Edu.453 Educational Psychology **3+0** **Sem.I**

Application of educational psychology in teaching. Relative role of heredity and environment in learning. Types of learning-cognitive, affective and psychomotor. Levels of learning-signal, stimulus-response, chaining, association, discrimination, concept formation, problems-solving. Creativity and motor skills. Motivation in learning. Learning disability and maturational age. Teaching situations and learning principles. Directed versus non-directed teaching. Education for personality development. Group behaviour in classroom situations. Application of Flanders' and other interactional models to classroom situations. Training needs of teachers' as professionals. Approaches and methodologies for effective development and training of teachers.

Edu.454 Methods and Innovations in Teaching **2+0** **Sem.I**

Technological and methodological innovations in teaching-methods, techniques and devices used in teaching. A functional treatment of traditional and modern methods, techniques and devices for teaching, such as Dalton Plan, observation heuristic, brain storming, group tutorial, project, discussion, programmed

instruction, individualised instruction, playway, excursion, role playing. Preparation of lesson plans for teaching. Use of computers in school teaching.

Edu.455 Audio-Visual Aids in Education **1+2** **Sem.I**

Meaning, scope and importance of audio-visual aids in teaching-learning situations. Classification, selection and use of audio-visual aids.

Practical : Preparation and use of various projected and graphic aids for classroom teaching.

Edu.456 Practicum **0+6** **Sem.II**

(Practice in School teaching in any two of the prescribed subjects)

Edu.457 Educational Evaluation and Statistics **2+1** **Sem.II**

Testing and measurement of educational outcomes-cognitive, affective and psychomotor. Test planning. Items writing, essay and multiple choice tests. Test administration, scoring and interpretation of scores. Use of statistics and standardized tests in education. Basic statistical measures-measures of central tendency, dispersion, correlation and regression. Simple item analysis techniques. Reliability and validity of tests.

Practical : Practice in developing model tests and use of scoring techniques. Computation of mean variance and regression coefficients.

Edu.458 School Organization **3+0** **Sem.II**

Principles and practices of school organization. Special emphasis on organization of school education in Punjab. Economic implications of school education. Problems and techniques in school campus planning, operations and maintenance including landscaping and beautification. Organization and handling of school library. Organisation of curricular and co-curricular activities. Time-table planning and school discipline. School and community relationships. Services for students' health and hygiene. Formation of school budget and maintenance of accounts.

Edu.459 Educational Games and Hobbies **0+1** **Sem.II**

Importance and scope of educational games and hobbies in teaching-learning situations. Preparation and practice in the handling of various educational games and hobbies applicable at the school level.

Edu.460 Special Topics in Education **0+2** **Sem.II**

Each student will be required to make a systematic study and write a paper for classroom presentation of such topics as effective methods of teaching vocational skills, problems of testing school children vis-a-vis agriculture, home science, agro mechanics and other related subjects, curriculum development, preparation of instructional materials, educational surveys and data collection, vocational guidance and counseling.

Edu.461 Methods of Teaching Agriculture **2+1** **Sem.I**

Agriculture and its importance for rural schools. Brief history and development of agricultural education in India. Methods and problems connected with the teaching of agriculture. Scientific and environmental approach. Farm and its use in correlational teaching. Formation of skills. Factors affecting the acquisition of skills. Steps in teaching skills at school level. Micro-teaching in agriculture. Management of laboratory and production unit.

Practical : Preparation of model lesson plans and practice in effective methods of teaching agriculture in classroom and outside-class situations.

Edu.462 Methods of Teaching Horticulture **2+1** **Sem.I**

Horticulture and its importance for rural schools. Methods and problems connected with teaching of horticulture including landscaping, vegetable crops and fruits. Scientific and environmental approach. Fruit and vegetable garden and its use in correlational teaching. Formation of skills. Factors affecting the acquisition of skills. Steps in teaching skills at school level. Micro-teaching in horticulture units. Management of laboratory and production unit.

Practical : Preparation of model lesson plans including landscaping, vegetables and fruits and practice in effective methods of teaching horticulture in classroom and outside- class situations.

Edu.463 Methods of Teaching Animal Science **2+1** **Sem.I**

Animal science and its importance for rural schools. Methods and problems connected with teaching of animal science. Scientific and environmental approach. Dairy and poultry farms and their use in correlational teaching. Factors affecting the acquisition of skills. Steps in teaching skills at school level. Micro-teaching in animal science units. Management of laboratory and production unit.

Practical : Preparation of model lesson plans and practice in effective methods of teaching animal sciences in classroom and outside-class situations.

Edu.464 Methods of Teaching Agro-Mechanics **2+1** **Sem.I**

Agro-mechanics and its importance for rural schools. Methods and problems connected with teaching of agro-mechanics. Scientific and environmental approach. Workshop and its use in correlational teaching. Formation of skills. Factors affecting the acquisition of skills. Steps in teaching skills at school level. Micro-teaching in agro-mechanics. Management of laboratory and workshop.

Practical: Preparation of model lesson plans and practice in effective methods of teaching agro-mechanics in classroom and outside-class situations.

Edu.465 Methods of Teaching Home Science **2+1** **Sem.I**

Meaning, scope and aims of teaching Home Science. History of Home Science education in India. General principles, methods and use of audio-visual aids in teaching Home Science. Organization of classroom, maintenance of records and planning of lessons. Observation and participation in model lessons in vocations prescribed in the areas of Child Development, Clothing and Textiles, Home Management and Foods and Nutrition. Factors affecting the acquisition of skills. Steps in teaching skills at school level. Management of laboratory and production unit.

Practical : Preparation of model lesson plans and practice in effective methods of teaching home science in classroom situation.

Edu.466 Methods of Teaching Biology **2+1** **Sem.I**

Place of Biology in school curriculum. Methods and problems connected with teaching of Biology. Teaching and abilities to internalize basic concepts. Factors affecting the acquisition of skills. Steps in teaching skills at school level. Micro-teaching in Biology. Management of laboratory units.

Practical : Preparation of model lesson plans and practice in effective methods of teaching Biology in a classroom situation.

Edu.467 Methods of Teaching Physics and Chemistry **2+1** **Sem.I**

Place and aims of physics and chemistry in school curriculum. Physical facilities and methods of teaching physics and chemistry. Demonstrations, experiments, problem- solving and individualized practicals. Formation of practical skills and abilities.

Practical : Preparation of model lesson plans and practice in effective methods of teaching physics and chemistry.

Edu.468 Vocational Aptitude Testing **2+1** **Sem.II**

Concept and nature of aptitude and related terms such as attitude, aspiration and interest. Functions of aptitude in the development of vocational talents and abilities. Role of aptitude in vocational guidance and counseling. Major types of aptitude tests- intelligence, academic, manual dexterity, mechanical and artistic ability. Specific multiple aptitude tests, principles relating to construction, scoring and interpretation of aptitude tests.

Practical : Group and individual exercises in the development, administration and interpretation of given aptitude tests.

- Edu.469 Guidance and Counseling** **3+0** **Sem.II**
 Meaning, nature and scope of guidance. Philosophical, psychological and sociological bases of guidance. Major interests and attitudes of students. Organization of guidance and counseling cell. Psychology of handicapped and gifted children. Emotional stress among students and approaches to deal with them.
- Edu.470 Curriculum Development** **2+1** **Sem.II**
 Types of curriculum approaches used at the school level. Principles of curriculum development. Structuring model curricula in agriculture, agro-mechanics, home science and other vocational subjects.
 Practical : Group exercises in analyzing educational needs, stating educational objectives and developing a model curriculum in a given vocational subject.
- Edu.471 Preparation of Manuals and Text Books** **1+2** **Sem.I**
 Place of text books and manuals in school instruction. Qualities of a good text book and teaching manuals. Steps and skills in the preparation of text books and manuals. Role of National Council of Educational Research and Training, Punjab State Text Book Board, Punjab School Education Board, University Text Book Production Department and individual efforts in the production of new text books and translated works.
 Practical : Practice in the preparation of materials for a teaching manual and text book.
- Edu. 472 Methods of Teaching Fashion Designing** **2+1** **Sem. I**
 Meaning, scope and aims of teaching fashion designing. Place of fashion designing in school curriculum. General principles, methods and use of audio-visual aids in teaching fashion designing. Teaching skills for fashion designing. Gathering of concepts and ideas in fashion design market. Organisation of lecture rooms, maintenance of records and planning of lessons. Physical facilities for teaching fashion designing. Establishment and management of laboratory and production unit of fashion designing in school. Observation and participation in model lessons in vocations prescribed in the areas of fashion designing. Factors affecting the acquisition of skills. Steps in teaching skills at school level. Computer application in fashion designing. Problems related to teaching of fashion designing at school level.
 Practical: Preparation of model lesson plans and practice in effective methods of teaching fashion designing in class room situation.

FLORICULTURE AND LANDSCAPING

PROGRAMMES

1. M.Sc.

2. Ph. D.

COURSE REQUIREMENTS

M.Sc.

Field of Specialization:	Floriculture, Landscaping
Required Courses:	Flori. 501, Flori. 502, Flori. 503, Flori. 504
Supporting Courses:	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to the area of special interest and research problem.
Minor Fields:	Plant Breeding & Genetics, Biotechnology, Horticulture, Soil Science, Botany or any other as approved by Dean, Postgraduate Studies.
Deficiency courses for students with elective other than Horticulture	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization:	Floriculture, Landscaping
Required Courses:	Flori. 601, Flori. 602, Flori. 603
Supporting Courses:	Courses from subject matter fields (other than minor) relating to area of special interest and research problem
Minor Fields:	Plant Breeding & Genetics, Biotechnology, Horticulture, Soil Science, Botany or any other as approved by Dean, Postgraduate Studies.
Deficiency courses for students with M. Sc. (Agri.) in a discipline other than Floriculture and Landscaping	Flori. 501, Flori. 502, Flori. 503, Flori. 504 and other courses as recommended by Student's Advisory Committee.

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Flori. 301 Flower Cultivation and Landscape Gardening **1+1** **Sem.II**

Introduction to floriculture and landscaping. Package of practices for rose, jasmine, chrysanthemum, gladiolus, marigold and tuberose. Planning of gardens. Landscape-art principles, Formal and informal gardens. Use of trees, shrubs, climbers, palms, houseplants and seasonal flowers in the gardens. Making and maintenance of lawns.

Practical: Identification of trees, shrubs, climbers, houseplants, seasonal flowers. Layout of lawns and maintenance. Potting, repotting and maintenance of houseplants. Training and pruning of rose. Pinching and disbudding chrysanthemum. Planning of gardens and development of garden features. Post-harvest handling of cut flowers.

Undergraduate Elective/M.Sc. Supporting/Minor courses

Flori. 433 Commercial Floriculture and Landscaping **2+1** **Sem.I**

Scope, importance and export potential of floriculture, environment factors influencing plant growth and flower production in cut flowers. Production technology including varieties, propagation, soil, nutrition, disease and pests of important cut flowers. Post harvest handling, grading and packing cut flowers, pot and bedding plants. Flower seed production. History of gardening, characteristics of Hindu, Mughal, Japanese and English gardens. Principle groups of plants like trees, shrubs, climbers, shade loving plants, ground covers, their analysis and use in landscape composition. Principles of art and landscaping. Preparation of landscape plans for homes, farm complexes, small parks and institutions. Development and maintenance of rock, water and terrace gardens. Bonsai and dish gardens, project formulation and evaluation.

Practical: Preparation of plans and laying out of gardens. Identification of planting material and commercial varieties of flowers. Seed collection, germination tests and storage. Harvesting and handling of cut flowers. Judging of flowers and pot plants. Visit to local nurseries and florist centers.

Postgraduate Courses

Flori. 501 Production Technology of Flowers **3+1** **Sem.I**

Status of Floriculture in India and its potential in global trade. Nursery management. Propagation structures. Media for nursery production. Special nursery practices. Growing environment. Open and protected cultivation - Plant morphology, Soil requirements, artificial growing media, soil decontamination, planting methods, water and nutrient management, fertigation, weed management, ratooning, training and pruning, disbudding, special horticultural practices in rose, chrysanthemum, carnation, gerbera, gladiolus, tuberose, orchids, anthurium, aster, liliiums, tulip, bird of paradise, alstroemeria, dahlia, gypsophilla, limonium, stock, Jasmine, marigold, geranium, crossandra, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, gardenia, pandanus), annual flowers and cut foliage. Influence of environmental parameters on growth and flowering. Production for exhibition purposes. Use of growth regulators. Flower forcing and year round flowering through physiological interventions, chemical regulation, and environmental manipulation. Flower seed production. Post-harvest handling of flowers. Physiological disorders and remedies. IPM and IDM. Marketing, export potential. Institutional support. Agri Export Zones.

Practical: Description of varieties. Propagation techniques. Mist chamber operation. Training and pruning techniques. Practices in manuring, drip and fertigation, foliar nutrition, growth regulator application,

pinching, disbudding, staking. Harvesting techniques. Post-harvest handling. Project preparation for regionally important cut flowers. Visit to commercial cut flower units and case study.

Flori. 502 Breeding of Flower Crops and Ornamental Plants **2+1** **Sem.II**

Origin, distribution, genetic resources, genetic divergence and evolution of varieties. Genetic inheritance of flower colour, doubleness, flower size, fragrance, post harvest life. Breeding methods suitable for sexually and asexually propagated ornamental plants. Introduction, selection, domestication, polyploidy and mutation breeding for varietal development. Role of heterosis. Production of hybrids. Male sterility and self-incompatibility. Breeding of commercial flowers - rose, chrysanthemum, marigold, tuberose, carnation, dahlia, gerbera, gladiolus, orchids, anthurium, lilioms, nerium. Breeding of annuals (zinnia, petunia, cosmos, dianthus, snapdragon, pansy), ornamental plants (hibiscus, bougainvillea, Jasminum). Introduction and selection of plants for waterscaping and xeriscaping.

Practical: Description of botanical features. Cataloguing of cultivars, varieties and species in flowers. Floral biology. Selfing and crossing. Evaluation of hybrid progenies. Seed production. Induction of mutation through physical and chemical mutagens. Induction of polyploidy. Screening of plants for biotic, abiotic stresses and environmental pollution. In vitro breeding in ornamental plants.

Flori. 503 Landscaping and Ornamental Gardening **2+1** **Sem.I**

Principles of art and their application in landscape compositions and interior decoration. Types and styles of gardens. Natural and man-made forms and features. Organization of spaces. Visual aspects of plan arrangement-view, vista and axis. Principles of circulation. Structures in landscape. Factors affecting growth and distribution of plants. Classification of plant material and identification. Principle groups of plants and their analysis from design view point. Nursery production of ornamentals. Maintenance of plant material. Growth habits and physiological requirements for growing of plants for interior decoration.

Practical: Study of violation of art and landscape principles. Identification and analysis of plant material for their use in landscaping. Propagation techniques of ornamentals. Maintenance of plant material including indoor plants. Study tours to gardens and arboretums.

Flori. 504 Landscape Designs (Pre-requisite: Flori. 503) **2+2** **Sem.II**

Analysis of various types of sites and their landscape treatment. Application of Landscape principles for various types of houses, educational institutions, religious places, fair grounds, industrial sites, rural habitat, farm complexes, embassies, hotels and other buildings. Special problems of landscaping of terrace and roof gardens and multistory buildings. Water scaping, xeriscaping, hardscaping. Landscaping of various categories of roads. Concepts and significance of planning cities and open spaces. Master plan of cities in relation to open spaces. Types of parks and other recreational areas. Maintenance of parks. Factors affecting outdoor recreation.

Practical: Site analysis of various landscape projects. Use of drawing scale, lettering, plotting, reading and interpretation of maps on different scales. Preparation of landscape designs of various types of buildings, roads, parks, sport centers, picnic spots, and camping grounds. Display of plants for interior decoration. Preparation of cost estimates for landscaping and maintenance. Study tours. Introduction to CAD.

Flori. 505 Protected Floriculture (Collaboration: Deptt. of Soil and Water Engineering) **2+1** **Sem.II**

Prospects of protected floriculture in India. Types of protected structures. Designing and erection of protected structures. Economics of cultivation. Location specific designs. Structural components. Flower crops for protected cultivation. Environment control. Containers and substrates, soil decontamination. Layout of drip and fertigation system. Water and nutrient management. Weed management. Physiological disorders. IPM and IDM. Crop regulation by chemical methods and special horticultural practices. Staking and netting. Photoperiod regulation. Harvest indices, harvesting techniques and Post-harvest handling.

Practical: Study of protected structures. Soil preparation and sterilization. Practices in environmental control systems. Drip and fertigation techniques. Special horticultural practices. Determination of harvest indices, harvesting methods and postharvest handling. Packing methods. Project preparation. Visit to commercial greenhouses.

Flori. 506 Value Addition in Flowers **2+1** **Sem.I**

Status and prospects of value addition. Types of value added products. Value addition in loose flowers - garlands, veni, floral decorations. Value addition in cut flowers- types of flower arrangement, bouquets, button-holes, flower baskets, floral wreaths. Selection of containers and accessories for floral products and decorations. Terrariums. Dry flowers- Identification and selection of flowers and plant parts, raw material procurement, preservation and storage. Techniques in dry flower making - Drying, bleaching, dyeing, embedding, pressing. Accessories. Designing and arrangement - dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths. Packing and storage. Concrete and essential oils - selection of species and varieties (including non-conventional species). Extraction methods. Packing and storage. Selection of species and varieties for pigment extraction. Types of pigments - carotenoids, anthocyanin, chlorophyll, betalains. Significance of natural pigments.

Practical: Practices in preparation of 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, pot-pourri, wall hangings, button holes, greeting cards, wreaths. Visit to dry flower units, concrete and essential oil extraction units.

Flori. 507 Turfing and Turf Management **2+1** **Sem.I**

Status and prospects of turf grass. Site selection and evaluation. Physical, chemical and biological properties of soil for turf grass establishment. Turf grasses - Types, species, varieties, hybrids. Selection of grasses for different locations. Grouping according to climatic requirement- adaptation. Turfing for roof gardens. Preparatory operations. Growing media used for turf grasses. Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding. Turf management - Irrigation, nutrition, special practices - aerating, rolling, soil top dressing. Use of plant growth regulators (PGRs) and micronutrients. Turf mowing- mowing equipments, weed control. Biotic and abiotic stress management in turfs. Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, etc.

Practical: Identification of turf grasses. Preparatory operations in turf making. Practices in turf establishment. Layout of 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 IT parks, model cricket and golf grounds, corporates, Govt. organizations. Renovation of lawns.

Flori. 508 CAD for Outdoor and Indoor Landscaping **1+2** **Sem.I**

Applications of CAD in landscape garden designing, 2D drawing byAUTOCAD, Basics of Photoshop software in garden designing. Toolbars and Icons, File handling functions, Modifying tools. Dimension concepts, Hyper linking, Making layout. Dimensioning and detailing of designs, Visualization tools for landscape preview, Data management, plotting and accessories for designing.

Practical: Practices in point picking methods. Using tool bars and icons. Using modifying tools and modifying comments. Isometric drawings. Using productivity tools. Drawing designs byAUTOCAD for home garden, institutional gardens, interior garden design, IT parks, corporates, theme parks and ecotourism spots. Using Photoshop for 3D picture insertion.

Flori. 601 Advances in Flower Production Technology **3+0** **Sem.II**

Commercial flower production. Global scenario in cut flower production and trade, varietal wealth and diversity. Soil and Environment. Special characteristics and requirements. Cut flower, loose flowers, dry flowers and floral oil trade. Propagation and multiplication. IPR issues related to propagation of materials. Greenhouse management. Soil/media decontamination techniques. Microirrigation. Nutrition and fertigation. Slow release fertilizers and biofertilizers. Influence of environmental parameters on growth and flowering. Regulation for quality flowers. Flower forcing and year-round flowering through physiological interventions, chemical regulation and environmental manipulation. Harvest indices, Harvesting techniques and Post-harvest handling. Export potential. Agri Export Zones. Crop specific practices - rose, anthurium, orchids, carnation, gladiolus, gerbera, lilliums, heliconia, bird of paradise, Jasminum sp., marigold, tuberose, crossandra. Floral oil industry - floral concrete production, extraction methods and recent advances.

- Flori. 602 Advances in Breeding of Flower Crops** **3+0** **Sem. I**
 Origin, evolution and distribution of varieties. Plant introduction, selection and domestication. Inheritance of important characters. Genetic mechanisms associated with flower colour, flower size, doubleness, fragrance and post-harvest life. Plant Variety Protection Act. Specific objectives of breeding in flower crops. Methods of breeding suited to seed and vegetatively propagated flower crops. Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties. Exploitation of heterosis. Utilization of male sterility. Incompatibility problems. In Vitro breeding. Breeding for resistance to pests, diseases, nematodes and other biotic and abiotic stresses in flower crops. Specific breeding problems and achievements made in rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, gerbera, gladiolus, orchids, anthurium, aster, petunia, lilliums, heliconia, bird of paradise, hibiscus and bougainvillea.
- Flori. 603 Advances in Landscape Architecture** **1+2** **Sem.I**
 Commercial landscape gardening- History, Plant identification and ecology. Materials of garden design. Design making by different garden styles and types. Expenses to model landscaping units of all category. Creativity and communication skills for landscape architect. Assessing site and plants adaptability for different locations. Landscape engineering (Topographical) survey and designing concept. Special techniques in garden landscaping (Waterscaping, hardscaping, topiary styles specializing). 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. Execution strategies. Assessing a successful design in site.
 Practical: Commercial landscaping. Plant identification. Materials of garden design. Design making by different garden styles and types. Way of designing a commercial landscape project. Visit to model ornamental nursery. Assessing site and plants adaptability for different locations. Landscape engineering. Special techniques in garden landscaping. Preparing drawing for site plan. Computer Aided Design (CAD) for developing a garden landscape plan. Handling soft landscape materials. GIS as a tool for spatial designing. Contemporary, Environmental, Industrial and institutional landscaping. Public and private garden making. Play ground landscaping. Case study with the successful landscapist. Budget/Project cost estimating and execution.
- Flori. 604 Advances in Pre and Post-harvest Management of Ornamentals** **3+0** **Sem.II**
 Recent advances in plant growth regulation in relation to photoperiodism, temperature and other environmental factor. Bulb culture, dormancy and storage of bulbs. Flower forcing in bulbous ornamentals. Physiology of flowering. Plant hormones-biosynthesis, signal transduction and role in floriculture. Factors influencing juvenility and strategies to overcome. Physiological disorders of ornamental plants. Biochemistry of flowers: Principles involved in the formation of pigments - chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins. Recent trends- Extraction of biocolours and their value addition, uses in food and textile industries. Effects of pre-harvest environments on post harvest quality of cut flowers. Harvesting of flowers and florist greens. Factors affecting decline in vase life. Importance of cool chain. Floral preservatives, storage, grading, packing and transportation of cut flowers. Functional and ultrastructural changes during petal senescence. Molecular basis of flower senescence. Biotechnological approaches to improve vase life.
- Flori. 605 Advances in Nursery Production and Management** **2+0** **Sem.I**
 Planning and establishment of a landscape nursery-selection of site and lay out. Propagation structures- Greenhouse, glasshouse, lathouse, mist chambers, net houses etc. Soil sterilization, raising seedlings, Plug production, grading, packing, storing, merchandizing and inventory making of ornamentals. Weed management. Media and containers for propagation of plants. Maintenance of stock plants. Advances in the principles underlying sexual and asexual propagation of different ornamentals. Factors influencing germination of seeds. Physiology of rooting, graft union, Stock scion incompatibility. Use of growth regulators in propagation. In vitro techniques of mass multiplication. Integrated management of important insect-pests and diseases in nursery. Customer services.

Flori. 606 Advances in Protected and Precision Floriculture **2+0** **Sem.II**

Prospects of protected floriculture in India. Growing structures. Basic considerations in establishment and operation of green houses, functioning and maintenance. Environmental control systems in greenhouse. Containers, substrate culture, soil decontamination techniques. Water and nutrient management. Crop regulation. Protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, lilliums, cut foliage. Marketing and export potential. Precision floriculture. Principles and concepts. Enabling technologies of precision farming, GPS, GIS, Remote sensing, sensors. Variability management in precision farming, mapping, variable rate technology. Precision equipments - computers and robotics in precision farming. Post-harvest process management in floriculture using precision farming.

Flori. 607 Planning and Management of Parks **2+0** **Sem.II**

Recreational parks - history, importance, scope and their role in outdoor recreation and nature conservation. Biotic regions of the world. Types of distribution of vegetation in India. Bio- aesthetic planning, Planning and designing of Botanical gardens, amusement and zoological parks. Maintenance of historical and archeological sites, recreational gardens, Wet lands, National parks, and wild life sanctuaries.

Flori. 591 Seminar

Flori. 600 Master's Research

Flori. 700 Ph.D. Research

FOOD SCIENCE AND TECHNOLOGY

PROGRAMMES

1. **B.Tech. Food Technology**
2. **M.Sc.**
3. **Ph.D.**

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Cereal Technology, Fruit and Vegetable Technology, Dairy Technology, Egg and Meat Technology
Required Courses	FT 501, FT 502, FT 503, FT 504, FT 505, FT 506
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to the area of special interest and research problem
Minor Fields	Microbiology, Biochemistry, Processing and Food Engineering, Food and Nutrition or any other as approved by the Dean, Postgraduate Studies
Deficiency courses for students with elective field other than Post Harvest Technology and Value Addition	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Cereal Technology, Fruit and Vegetable Technology, Dairy Technology, Egg and Meat Technology
Required Courses	FT 601, FT 602, FT 603, FT 604
Supporting Courses	Courses from subject matter fields (other than minor) relating to area of special interest and research problem
Minor Fields	Microbiology, Biochemistry, Processing and Food Engineering, Food and Nutrition or any other as approved by the Dean, Postgraduate Studies
Deficiency courses for Students with M.Sc. (Agri.) in a discipline other than Food Science and Technology	FT 501, FT 502, FT 503, FT 504, FT 505, FT 506 and other courses as recommended by Student's Advisory Committee

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

- FT 101 Food Production Trends and Programmes** **2+0** **Sem.I & II**
Global food demand and supply. Technological advances to meet the needs, future priorities. Food production and availability of processed, semi processed, ready-to-eat and fast foods. Food characteristics, nutritional significance of major food groups. Consumption trends. New food product development programmes for more availability to increasing population, their prospects - merits and drawbacks. National and international trends and programmes in food handling, processing and marketing. Food losses - factors affecting, programmes and strategies to eliminate the losses. Status of food industry in India and abroad.
- FT 102 Principles of Food Processing and Preservation** **2+1** **Sem. II**
Sources of food. Scope and benefit of food preservation. Causes of food spoilage. Thermal processing and preservation by blanching, canning, pasteurization, sterilization, drying, dehydration and concentration. Use of low temperature. Concentration by freezing and membrane technology. Preservation by radiation, chemicals and fermentation. Effect of preservative methods on foods quality. Recent methods in food processing and preservation: pulse electric field, high pressure, ultrasound, microwave, ohmic and infrared heating.
Practical: Demonstration of various machineries used in processing. Blanching of fruits and vegetables. Preservation of food by heat treatment-canning, sugar, salt, acidulants, chemicals and fermentation. Preparation of bread and cake using mold inhibitors. Drying of fruits and vegetables. Low temperature preservation-cold vs. freezing.
- FT 201 Technology of Fish and Marine Foods** **1+1** **Sem. I**
Types of fish, composition, structure and post-mortem changes in fish. Handling of fresh water fish. Processing and preservation of fish-canning, smoking, chilling and freezing, salting, sun-drying and curing. Fish sausages. Freeze-drying of fish/shrimp. Radiation processing and safety. Fermented fish products. Fish protein concentrate. Marine oils and fish meals. Marine algal products. Utilization of fish and marine industry by-products.
Practical: Anatomy and dressing of fish. Preparation of fish and marine products - sun-dried, salt cured, sausages, protein concentrate, meal and oil. Chilling and freezing of fish. Preparation of marine algal products. Utilization of fish by-products.
- FT 202 Food Quality** **1+1** **Sem.I**
Food quality and its role in food industry. Physical quality attributes such as colour, size, shape, viscosity, consistency, flavours, their role in food quality and methods of assessment. Chemical and microbiological quality of food. Sensory quality evaluation - panel screening, selection and methods. Sensory and instrumental analysis in quality control. Sampling and specification of raw material and finished products. Food grades and standards.
Practical: Techniques for quality assessment of fruits, vegetables, cereals, dairy products, meat, poultry, fish, marine, raw / processed products. Sensory evaluation of products. Visit to food industry
- FT 203 Food Packaging** **2+1** **Sem.II**
Importance and scope of packaging. Packaging requirements, functions and hazards acting on package during transportation. Labelling laws. Packaging Materials: classification of packages-corrugated and paper board boxes, glass, metal, aluminium and plastic as package material. Classification of polymers, their properties and uses. Lamination types and, properties. Coating on paper and films. Types and methods of coating. Aseptic packaging- process, comparison with conventional packaging, system and materials

used for aseptic packaging. Machineries used in packaging of foods. Packaging of specific foods. Mechanical and functional tests on packages.

Practical: Classification of various packages based on material and rigidity. Identification of plastic films. Measurement of thickness, weight, water absorption, bursting strength, tear resistance, puncture resistance and tensile strength of packaging materials. Measurement of grease resistance of paper. Determination of gas, water vapour and oil transmission rate of package films. Determination of coating on package materials. Pre-packaging practices followed for packaging of fruits and vegetables. Visit to packaging industry.

FT 204 Technology of Extruded Food Products **2+1** **Sem. II**

Introduction to food extrusion technology -importance, principles and methods. Components of extruder, types of extruders - single screw, twin screw, co-rotating and counter rotating etc. Classification of extruders based on shear, cooking, process description - feeding, compression and cooking zones, independent and dependent variables. Raw materials - structure forming, filling materials, plasticizers/lubricants, nucleating, flavouring and colouring agents. Effect of extrusion on food components and food properties.

Applications of extrusion - breakfast cereals, snacks, co-extruded foods, third generation snacks, texturized vegetable proteins (TVP) etc. Quality evaluation and packaging requirements.

Practical: Parts and types of extruders, preparation of breakfast cereals, snacks, co-extruded products, texturized vegetable proteins (TVP). Demonstration: effects of extrusion variables on process and product quality.

FT 302 Introduction to Food Science and Post Harvest Value Addition **1+1** **Sem. I & II**

Food production and consumption trends in India. Major deficiencies of calories and proteins. Food groups and concept of balanced diet. Causes of food spoilage. Principles of processing and preservation of foods by heat, low temperature, chemicals and fermentation. Preservation through ultraviolet and ionizing radiations. Post harvest handling and technology of fruits, vegetables, cereals, oilseeds, milk, egg, meat and poultry. Food safety, adulteration and food laws. Status of food industry in India.

Practical: Quality assessment of cereals, fruits, vegetables, milk, egg, meat and poultry. Value added products from cereals, fruits, vegetables, milk, egg and meat. Visit to local processing units.

FT 303 Food Additives **2+1** **Sem.I**

Nutritional and non-nutritional food additives. Naturally occurring food additives -vitamins, minerals and amino acids. Food colour, pigments, their importance and utilization. Taste and flavour inducers. Food preservatives and their chemical action. Role and mode of action of salts, chelating agents, stabilizers, thickeners, polyhydric alcohol, anticaking, firming, colouring, bleaching and antimicrobial agents, antioxidants, non-nutritional sweeteners.

Practical: Description of generally recommended as safe (GRAS) food additives. Spectrophotometric method for total chlorophyll. Determination of diacetyl content of butter. Clarification of fruit juices, antioxidants in frozen fish. Use of additives in bakery, fruits, vegetables, milk and meat products.

FT 304 Food Industry By-products **1+1** **Sem.I**

Potential and prospects of food industry waste by-products. By-products of cereals, legumes, oil seeds, dairy, fruits and vegetables, meat, poultry and eggs, fish, plantation crops, spices, fermentation, sugar and bakery industries. Utilization of food industry waste by-products.

Practical: Alcohol production from molasses. Utilization of fruits, vegetables, dairy, meat and fish industry wastes. Pectin from organic waste. Biscuits and muffins from cereal brans.

FT 305 Food Safety, Laws and Regulations **2+1** **Sem.II**

Need for enforcing the food laws and various types of laws. Food Safety and Standards Act 2006. Microbial, metal and pesticide residues. Prevention of Food Adulteration Act. Central committee for food standards, duties of food safety officer and public analyst. Sealing, fastening and dispatch of samples. Report of Public analyst. Powers of court. Standard Weight and Measures Act, Essential Commodity Act, Consumer Protection Act, Environmental Protection Act, Insecticide Act, Export quality control and inspection Act. Various food orders: Fruit Product Order, Milk and Milk Product Order, Edible Oil Package Order, Meat Food Products Order. Optional food standards: procedure to obtain the standards - Agmark and Bureau of

Indian Standards. CODEX STANDARDS for cereals, pulses, fruits, vegetables, meat and poultry products. Recommended International Code of Hygiene for various products.

Practical: Examination of Cereals and pulses from a godown and market shop in relation to FPO and BIS specifications. Estimation of toxins in food samples. Examination of various food products as per food standards. Visit to quality control laboratory and food processing industry.

FT 306 Speciality Foods **1+1** **Sem. I & II**

Need and scope of speciality foods. Speciality foods based on ease in preparation, cost, health benefits; functional foods, convenience foods and nutritive value. Speciality foods based on plant and animal kingdom, innovative process technology, food additives, bio-active components, nutraceutical, packaging techniques and adaptable technology. Fast foods. Genetically modified foods and biotechnological aspects of detoxification. Supplementary and therapeutic foods. Foods for defence personnel, space / astronaut, high altitude mountain climbers, disaster situation crises / care / maintenance. Foods from organic and inorganic farming produce.

Practical: Preparation of speciality foods from plant and animal kingdom sources based on functionality, convenience, cost, and nutritive value. Assessment of by-products for preparation of value added speciality food. Isolation of nutraceuticals and their utilization in foods. Visit to organic farm and speciality food industry.

FT 307 Technology of Food Beverages **1+1** **Sem. II**

Theory: Potable water quality parameters; treatment of water for beverage industry; microbiological status; water standards for beverages. Mineral water - specifications, processing and packaging. General methods of preparation and inspection of non alcoholic beverages. Chemical composition, nutritive value and functions of ingredients used in carbonated beverages. Bottling and packaging of soft drinks. History, area in India under production of coffee, tea types, production practices and flow diagram of processing of tea and coffee. Introduction to alcoholic beverages, types and manufacturing processes.

Practical: Sampling of water for testing. Quality tests of water - physical, chemical, microbiological. Preparation, packaging and testing of carbonated non-alcoholic beverages. Quality testing of tea and its beverage. Quality testing of coffee and its beverage. Preparation, packaging and testing of wine.

FT 401 Quality Assurance and Certification **2+1** **Sem.II**

Quality inspection, control, management and assurance. Total quality management (TQM) - Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP), Good Laboratory Practices (GLP), Quality Management System (QMS). Quality Circles, Statistical Quality Control. International Standards Organization. Hazard Analysis Critical Control Point - principle, implementation, plan documentation, types of records. Auditing - surveillance, audit, mock audit, third party quality certifying audit, auditors and lead auditors. Certification - certification procedures, certifying, accrediting and International bodies.

Practical: Quality Assurance procedure. TQM, GMP, GAP documentation. Preparation of Quality Policy and documentation (Quality Manuals). Preparation of Laboratory manuals. Application of HACCP to Products. Preparation of documentation and records. Auditing- surveillance, mock audit. Visit to units implementing GMP, GAP, ISO and HACCP.

FT 402 Confectionery and Bakery Technology **2+1** **Sem.I**

Sugar, glucose syrup and other sweeteners. Crystalline and non-crystalline confectionary, fondant, hard boiled candy, caramel, toffee, fudge, marshmallow, nougat, fruit chews, jellies, gums, pastilles, marzipan, lozenges, panning. Defects in confectionary. Chewing and bubble gum. Chocolate confectionary-cocoa processing, chocolate manufacture, bars and coated chocolates, emulsifiers in chocolates, cocoa butter substitutes. Introduction to bakery industry. Role of bakery ingredients. Specifications and testing of raw materials. Bread making by various methods. Testing of final products. Staleness, ropiness and other defects in bread. Baked products from soft wheat - cookies, crackers, biscuits. Cakes - types, ingredients, process, defects and remedies. Other bakery products - pizza and pastry. Macaroni products-spaghetti, noodles, vermicelli. Nutritional improvement of bakery products and packaging.

Practical: Physical properties of sugar. Determination of moisture and reducing sugars in sugar. Preparation of fondant, high boiled candy, toffee, butter scotch, pulled sugar, jellies and gums. Visit to confectionary

industry. Preparation of cakes, biscuits, cookies, crackers, buns, pastry, pizza, vermicelli, noodles etc. Shelf life and quality of bakery products.

FT 403 Technology of Legumes and Oilseeds

2+1

Sem.I

Chemical composition, nutritional value, anti-nutritional factors and methods of removal of anti-nutritional factors. Processing of legumes. Dal milling - principle, methods, equipments and dal quality. Dry and wet milling of pulses. Soaking, sprouting, puffing. Roasting and parboiling of legumes - physico-chemical changes. Cooking quality of dal. Post-harvest technology of oil seeds - handling, drying, storage, cleaning, grading, pre-treatments, de-hulling, size reduction and flaking. Oil extraction-traditional and modern methods. Solvent extraction. Desolventization. Refining of oil. New technologies in oil seed processing. Utilization of oil seed meal for food uses. Protein concentrate and isolate.

Practical: Physical properties of legumes and oil seeds. Estimation of protein and fat. Dehulling of dal-application of oil and red earth slurry. Dal milling process. Elimination of antinutritional factors in legumes-washing, soaking and sprouting. Cooking quality of dal. Extraction of oil by expeller and screw press. Preparation of protein concentrate and isolate. Visit to dal mill and oil extraction plant.

FT 404 Technology of Plantation Crops and Spices

1+1

Sem.I

Production and processing scenario of spices, flavour and plantation crops. Post-harvest technology-composition and processed products of major and minor spices. Processing and utilization of spices, annie seeds, sweet basils, caraway seed, cassia, cinnamon, clove, coriander, cumin, dill seed, fern seed, nutmeg, mint, marjoram, rose merry, saffron, sage, savoury, thyme, ajowan, curry leaves. Tea-types, processing, quality control. Processing of coffee, cocoa, vanilla and annatto. Flavours of minor and major spices. Spice oleoresins. Flavours of soft drinks, bakery and confectionery. Specifications of spices.

Practical: Identification and characterization of flavouring compounds of spices. Extraction of oil from clove, pepper, cardamom, chilli. Extraction of oleoresins - turmeric, ginger, pepper, clove and estimation of principle components. Determination of moisture and oil in spices. Specific gravity, refractive index and acid value of oleoresins. Study of standard specification of spices. Preparation of curry powder. Visit to spice industry.

B. Tech./ Undergraduate Elective /M.Sc. Supporting / Minor Courses

FT 433 Fruit and Vegetable Technology

2+1

Sem.I

Present status and scope of Fruit & Vegetable Industry in India. Principles and preservation of fruits and vegetables by thermal processing, low temperature, chemicals, irradiation, salt, sugar and high pressure. Preparation of jams, jellies, marmalades, juices, squashes, ketchup, pickles, chutneys, wine and vinegar. Role of pectin in gel formation. Quality characteristics of fruit and vegetable products. Selection of site, design, layout, equipment, machinery and buildings. Plant sanitation. Disposal of wastes from fruit and vegetable processing plants. Project formulation and evaluation.

Practical: Canning of fruits and vegetables. Dehydration of fruits and vegetables. Preparation of fruit juices, squashes, jams, jellies, marmalades, ketchup, pickles, chutneys, preserve, candy, wine and vinegar. Organoleptic evaluation of fruit and vegetable products. Visit to food industry.

FT 434 Dairy Technology

2+1

Sem.I

Physico-chemical properties of milk. Liquid milk processing - clarification, pasteurization, homogenization, chilling and packaging. Fluid milk - toned, double toned, standardized, recombined and reconstituted. Fermented milks - natural, cultured buttermilk, acidophilus, bulgaricus, kafir and koumiss. Preparation of milk products-cheese, condensed and evaporated milks. Whole and skim milk powder and ice cream. Legal and BIS standards of milk and milk products. Plant sanitation and effluent disposal. Utilization of by-products. Dairy plant layout and project formulation.

Practical: quality evaluation of fluid milk. Detection of adulteration in milk and milk products. Preparation of milk products - cheese, flavoured pasteurized, sterilized and fermented milk, ice cream, yoghurt, khoa and paneer. Visit to milk plant.

FT 435 Cereal Technology **2+1** **Sem.I**

Structure of different grains-wheat, rice, barley, oat, corn and millets. Milling of grains. Flour and its use in bakery products- bread, biscuits, cakes, dough nuts and buns. Milling and parboiling of paddy. Rice bran oil. Pearling and malting of barley. Preparation of oat flakes and dalia. Wet and dry milling of corn. Preparation of extruded products. Sanitation of cereal processing plant. Project formulation and evaluation.

Practical: Determination of quality characteristics of wheat, wheat flour and atta. Rice milling and parboiling. Pearling and malting of barley. Preparation of chapaties, bread, biscuits, cakes, buns, rusks, flat bread, broken wheat i.e. porridge, puffed and extruded products.

FT 436 Egg and Meat Technology **2+1** **Sem.I**

Structure, composition, nutritive value and functional properties of eggs. Interior quality of eggs and its preservation. Preparation of egg products. Scope of meat and poultry processing industry in India. Slaughtering and dressing of poultry and other meat animals. Structure, composition, nutritive value and post-mortem bio-chemical changes in relation to quality of meat tissues. Meat tenderization. Principles of meat preservation. Standards and quality control measures for meat and poultry processing plant. By-products. Plant layout and project formulation.

Practical: Evaluation of quality and grading of eggs. Preservation of shell eggs. Preparation of various egg products. Slaughtering and dressing of poultry and meat animals. Preparation of meat cuts. Chilling and ageing of meat. Estimation of meat: bone ratio. Preparation of meat- products-canned, dehydrated, barbecued and comminuted. Preparation of sausages, loaves, burger, patties, fish fingers, kabab and restructured meat and poultry products.

FT 499 Industrial Training **0+20** **Sem. II**

After the completion of the course work, the B. Tech. Food Technology (Hons.) students would undergo compulsory Industrial Training in food industry for the duration of one semester. The students after acceptance by the food industry will submit plan of work to the class teacher(s) within two weeks of joining. The students will be required to submit detailed project report two weeks prior to the end of the semester. The evaluation of the Industrial Training will be based on the project report submitted, industry manager's report and oral presentation cum viva voce.

Postgraduate Courses

FT 501/FN 512 Principles of Food Processing **2+1** **Sem. I**

Scope of food processing and historical developments. Principles and methods of food processing and preservation - blanching, pasteurization, sterilization and UHT processing, aseptic processing, canning, extrusion, baking, roasting, frying, drying, concentration and evaporation dielectric and microwave heating, refrigeration, freezing, controlled atmosphere (CA), modified atmosphere (MA), and dehydro-freezing. Non-thermal methods- irradiation, high pressure, pulsed electric field, hurdle technology, minimal processing and membrane technology. Food fermentations, pickling, smoking and chemical preservation.

Practical: Canning, freeze drying, dehydration, concentration, refrigeration and freezing of foods. Determination of thermal inactivation time of enzymes. Use of chemicals in preservation of foods. Extrusion cooking. Preparation of intermediate moisture and fermented foods. Visit to a food processing plant.

FT 502 Food Additives and Ingredients **2+1** **Sem. I**

Food additives - definition, classification and functions. Preservatives, antioxidants, colours, flavours, emulsifiers, sequesterants, humectants, hydrocolloids, sweeteners, acidulants, buffering salts, anticaking agents - their food uses and functions in formulations. Toxicological evaluation of food additives. Flavours-types, generation during processing and reactions. Flavour composites. Stability of flavours during food processing. Analysis and extraction techniques of flavours. Flavour emulsions. Essential oils and oleoresins, authentication of flavours. Proteins, starch and lipids as functional ingredients. Functional properties of nutraceuticals and fibre - their application in food.

Practical: Estimation of preservatives, sweeteners, fibre, colours, antioxidants, flavour enhancers. Functional properties of native and modified proteins, starch and lipids. Extraction of essential oil and oleoresins. Applications of additives and ingredients in foods

- FT 503 Food Quality Systems and Management** **2+1** **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 different food industries. Food adulteration and food safety. IPR and Patents.
 Practical: Assessment of quality attributes of raw and processed foods. Detection and estimation of food additives and adulterants. Quality assurance procedure, Preparation of quality policy & documentation. Implementation of HACCP. Visit to Units with ISO systems and with HACCP certification. Sensory & instrumental method for measuring food attributes, aflatoxins, pesticides & insecticide residues.
- FT 504 Enzymes in Food Processing** **2+1** **Sem.II**
 Enzymes- classification, properties, nature and mode of action. Sources and production of enzymes. Natural enzymes in foods - their significance in food processing. Commercial enzymes and their application in fruits (cell wall degrading enzymes for liquefaction, clarification, debittering, decolourization of very dark coloured juices), vegetables, milk (cheese making, whey processing), meat, poultry (tenderization) and egg, malting, brewing, baking (fungal ?- amylase for bread making, maltogenic?- amylases for anti-staling, xylanases, pentosanases and lipases as dough conditioners, oxidases as replacers of chemical oxidants) and confectionery. Enzymes for corn syrup solids (liquefaction, saccharification, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides. Enzyme processing for flavours. Enzymatic approach to tailor- made fats.
 Practical: Assay of enzymes in raw and processed foods. Applications of commercial enzymes in food product preparation- baking, starch hydrolysis, meat tenderization, cheese making and juice clarification.
- FT 505 Nutraceuticals and Health Foods** **2+1** **Sem. I**
 Introduction to nutraceuticals-definition, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals. Concept of angiogenesis and the role of nutraceuticals/functional foods. Nutraceuticals for various disorders and diseases- compounds and their mechanism of action and dosage level. Manufacturing aspects of selected nutraceuticals. Formulation of functional foods containing nutraceuticals- stability and analytical labelling issues. Clinical testing of nutraceuticals and health foods. Interactions of prescription drugs and nutraceuticals, adverse effects and toxicity of nutraceuticals. Nutrigenomics - an introduction and its relation to nutraceuticals.
 Practical: Market survey of existing health foods. Identification and estimation of selected nutraceuticals. Production and quality evaluation of foods containing nutraceuticals. Development of labels for health foods. Visit to relevant processing Units.
- FT 506 Inplant Training** **0+1 (NC)** **Sem. I & II**
 After the completion of theory, and research work, M.Sc. students would undergo compulsory inplant training in a food industry for a duration of six weeks. On completion of industrial inplant training the students will be required to submit a written training report. The students will be evaluated for awarding the grade on the basis of project report, industry manager's report, oral presentation and viva-voce.
- FT 507 Technology of Fruit 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 of fruits 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.

FT 508 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.

FT 509 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

FT 510 Technology of Meat, Poultry and Fish **2+1** **Sem. I**

Meat, Poultry and fish industry in India-Present status and scope. Structure and chemical composition of meat, Poultry and fish. Transportation of animals and birds. Modern abattoirs and poultry processing plants- lairage, facilities and procedures. Ante-mortem and post-mortem inspections. Conditioning of carcasses. Meat tenderization. Preservation, packaging, microbiology and recent advances in meat, fish and poultry processing and their products. Comminuted products. Hygiene and sanitation in meat, poultry and fish processing plants.. Evaluation of quality characteristics of fresh meat, poultry and their products. Quality evaluation of eggs. Manufacture of egg powder and other products. By-products of meat, fish and poultry industry. Preparation of fish oils, fish protein concentrate and other by-products.

Practical: Slaughtering and dressing of meat animals. Study of post-mortem changes. Meat cutting and handling. Evaluation of meat quality. Preservation by dehydration, freezing, canning, curing, smoking and pickling of fish and meat. Shelf-life studies on processed meat products. Evaluation of quality of eggs. Preservation of shell eggs. Estimation of meat: bone ratios. Preparation of meat products- barbecued sausages, loaves, burger and fish finger. Visit to meat processing plants.

FT 511/PFE 510 Food Packaging **2+1** **Sem. II**

Objectives and functions of packaging and packaging materials. Packaging requirements and selection of packaging materials. Types of packaging materials -paper, glass, metals, plastics- their properties and methods of testing and evaluation. Barrier properties of packaging materials- Theory of permeability and its measurement. Prediction of shelf life of foods, selection and design of packaging material for

different foods. Packaging systems for different foods. Packaging equipment and machinery-vacuum, controlled atmosphere and modified atmosphere. Seal and shrink packaging, form and fill sealing, aseptic packaging systems, bottling and carton making equipments. Biodegradable packaging. Recent advances in packaging.

Practical: Identification and testing of packaging materials. Determination of wax from wax paper. Measurement of tin coating weight. Sulphide stain test. Thickness, substance weight, water absorption, capability of flexible packaging materials. Determination of equilibrium moisture content. Grading of glass bottles for alkalinity. Determination of water vapour and gas transmission rate of packaging material. Vacuum and shrink packaging. Testing the compression strength of the boxes. Testing the strength of glass containers. Testing the strength of filled pouches by drop tester. Visit to packaging institute/industry.

FT 601 Advances in Food Technology **2+0** **Sem.II**

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. High Pressure processing-concept, equipments for HPP treatment, mechanism and its application. Ultrasonic processing- properties and applications. New techniques-high intensity light, pulse electric field, ohmic heating, infra red heating, inductive heating and pulsed X-rays and nanotechnology in food processing. Techniques in fortification and stability of nutrients in relation to processing. Flavour stabilization.

FT 602 Advanced Food Analysis **0+2** **Sem. I**

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).

FT 603 Product Design and Development **2+0** **Sem.II**

Product development. Innovation strategy. Product development programme. Product development process - strategy, design, development, commercialization, launch and evaluation. Development of new product, technological knowledge, raw material properties, processing, product qualities, packaging requirements, distribution and marketing. Role of consumers in product development - consumer behavior and food preferences. Managing and improving the product development process. Market exploration and acquisition. Legal aspects of new product launch.

FT 604 Carbohydrate Technology **2+1** **Sem. II**

Different carbohydrates in food products such as starch, cellulose, sugars, pectin, fibres (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; Newer carbohydrates for food applications such as xanthan, dextran, pullulan, gellan, curdlan and β - glucans (nutraceutical and functional properties) Stabilization of food systems, simulated and low-fat foods, Fat-substitutes based on carbohydrates, Carbohydrate-based biodegradable packaging.

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.

FT 605 Lipid Technology**2+1****Sem. I**

Nutritional aspects of food lipids and their sources- omega-3 and omega-6 fatty acids and their significance, Phytosterols and their nutraceutical significance. Measurement of lipid degradation parameters during deep-fat frying and storage of foods. Flavor emulsions and their stability. Fat powders like cream, butter, cod-liver oil etc. and techniques involved such as micro encapsulation, Fat substitutes based on carbohydrates and proteins. Formulation and characterization of low-fat spreads, whipped creams, margarines, mayonnaise, salad dressings etc. Bakery shortenings chemistry, formulation and technology. Trans-fatty acids- formation during processing and nutritional aspects, Enzymatic approach to tailor made fats.

Practical: Assay of lipid degradation and polymerization products in fried foods and fried oils; analysis of phytosterols, trans-fatty acids and omega fatty acids; preparation of fat and cream powders; formulation and stabilization of low fat spreads, margarines and mayonnaise based on locally available fats; applications of emulsifiers in industrially produced foods.

FT 606 Protein Technology**2+1****Sem. I**

Protein structure and chemistry; protein -protein interactions, methods of evaluation of protein quality and amount, Conventional and novel sources of protein. Production of proteins, 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.

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.

FT 491 B.Tech. Seminar**FT 591 Seminar****FT 600 Master's Research****FT 700 Ph.D. Research**

FORESTRY AND NATURAL RESOURCES

PROGRAMMES

M. Sc.

COURSE REQUIREMENTS

Field of Specialization	Silviculture and Forest Management, Tree Improvement, Agroforestry, Forest Ecology and Wildlife.
Required Courses	Forst. 501, Forst. 502, Forst. 503, Forst. 504, Forst.505, Forst. 506
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem.
Minor Fields	Agronomy, Biotechnology, Botany, Economics, Plant Breeding and Genetics, Vegetable Science, Fruit Science, Floriculture and Landscaping, Soil Science or any other as approved by the Dean, Postgraduate Studies
Deficiency courses for students with elective other than Agronomy, Soil Science and Forestry	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Forst. 301 Introductory Forestry	1+1	Sem. I
Forestry - definition, scope and important terminology. Status of forests in India and their role. History of forestry development in India. National and International Forestry Organizations. Distribution of forests and their classification. Tending operations. Locality factors: climatic, edaphic, topographical and biotic. Agroforestry, farm forestry and social forestry - definition, objectives and need. Role of trees in rural economy. Choice of species w.r.t. site/economic uses and constraints of tree growing. Tree propagation and planting methods. Deforestation - forms, causes and remedial measures. Forest management: growing stock, normal forest, sustained yield, increment and rotation. Forest utilization-major and minor forest products. Forest policy and laws. Practical: Identification of trees. Measurement of tree height, diameter, girth, bark thickness, increment, age and volume. Nursery raising and silvicultural practices of some economic forest trees viz., safeda, poplar, shisham, mulberry, kikar, sagwan, dek, bamboo and subabul.		

Undergraduate Elective /M. Sc. Supporting/Minor Courses

Forst. 433 Production Technology of Economic Forest Trees	2+1	Sem. I
Plantation silviculture: native versus exotics; even-aged versus uneven-aged; monoculture versus mixed culture. Plantation technology and tending operations of economically important tree species. Agroforestry concept and suitable agroforestry systems/models for different regions. Economic and ecological aspects of agroforestry systems. Importance of superior phenotypes, their evaluation and use in plantations. Climate change and forests. Forest regeneration, productivity and rotation. Desertification and rehabilitation of waste lands. Short rotation intensive management of forest plantations. Trees		

outside forests, energy/industrial plantation and dendro-remediation. Production and marketing of forestry produce. Forest fire and its management. Wood based industries and importance of non-timber forest produce. Framework for forestry extension: participatory rural appraisal and joint forest management.

Practical: Nursery management: propagation methods, quality planting stock, preparation of nursery and plantation schedule. Layout and establishment of agroforestry models. Estimation of tree volume and biomass; enumeration and vegetation survey. Methods of vegetation analysis: measurement of biomass and productivity. Visit to commercial plantations, wood based industries and forestry institutes.

Postgraduate Courses

Forst. 501 Silviculture **2+0** **Sem. I**

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation. Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation and water relationship, mineral nutrients and temperature. Stem cambium, shoot and crown development and root growth. Natural regeneration of species and types including uneven aged silviculture. Intermediate treatments. Plantation in arid, coastal, hilly regions, water logged and salt affected sites. Silviculture of pure and mixed stands. Advanced and modern nursery tools and techniques. Silvics and silviculture of important conifers and broadleaved tree species.

Forst. 502 Forest Biometry and Management **3+1** **Sem. II**

Definition, importance and scope. Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands. Preparation of volume, yield and stand tables and their application. Forest inventory, sampling methods adopted in forestry, use of GPS in forest inventory and computer analysis of inventory data. Measurement of stand density. Simulation techniques. Growth and yield prediction models - their preparation and applications. Principles of forest management; scope and objective of forest management, development of forest management in India. Need for man-made forests. Site quality evaluation and importance. Stand growth, classical approaches to yield regulation in forest management, salient features and strategies. Forest valuation and appraisal in regulated forests. Forests and its importance, forest societies, interactions between forests and people, social and cultural factors of forest management. Gender dimension of forest management, tribal economy and forests. Forests and food security, eco-tourism and local development, land use change and forestry.

Practical: Measuring instruments and procedures for tree and stand measurement. Calculations of volume of felled as well as standing trees. Volume table preparation. Application of sampling procedures. Handling of GPS. Preparation of yield and stand table. Visits to plantations of different age gradation, record the actual growing stock and increment.

Forst. 503 Forest Ecology and Biodiversity Conservation **2+1** **Sem. I**

Advances in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity. Hierarchy issues in ecology. Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserves). Global warming and forests. Green House Effect and its consequences. Ozone depletion. Conservation laws and acts. Forest genetic resources of India, timber and non-timber species. Survey exploration and sampling strategies. Documentation and evaluation of forest genetical resources (FGR), in situ and ex situ conservation of gene resources. Biological 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. Trip 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, wildlife sanctuaries, botanical gardens and arboreta.

Forst. 504 Forest Protection and Conservation **2+1** **Sem. II**

(In collaboration with Deptts. of Entomology, Plant Pathology and Zoology) Important pests of forest nurseries and plantations. Management strategies for control of pests. Breeding trees for resistance against key insects-pests and diseases. Mycoflora of tree seeds and management; role of mycorrhiza in tree

health. Assessment of losses by diseases, insects, vertebrates; deterioration of timber; microclimate influence on pests. Habitat management of vertebrate pests. Climatic factors, acid rain and air pollutants in relation to forest tree health. Forest fires and management. Wildlife damage in nurseries. Wildlife as important component of forest ecosystem. Importance and use of wildlife. Threats to wildlife. Role of people in wildlife conservation and awareness. Principles of wildlife conservation. Endangered species. Protected areas, zoos and wildlife conservation. Conservation acts. Extension and public participation. Minimum viable population size. General management plan for wild animals and special requirements. Management of zoos, wildlife sanctuaries and national parks. Management of harmful wildlife species. Climate change and wildlife.

Practical: Collection, identification and preservation of important insect-pests and disease specimens of forest trees, extraction of spores of VAM from soil and assessment of mycorrhizal root infestation, detection of insect infestation and seed borne mycoflora; estimation of losses caused by insects and diseases, laboratory tests for estimating decay resistance in wood, demonstration of power operated sprayer, spray technology for trees, fire control methods and devices.

Forst. 505 Tree Improvement **1+1** **Sem. I**

General concepts. Reproduction, dimorphism pollination mechanisms. Pollen dispersion and pollen handling. Pollination mechanisms. Variation in trees: importance and its causes. Natural variation as a basis for tree improvement. Geographic variations - Ecotypes, clines 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. Indirect selection for biotic and abiotic stresses.

Practical: Floral biology, modes of reproduction and modes of pollination. Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to species, provenance and progeny trials. Visit to seed orchards. Induction of polyploidy through colchicines treatment.

Forst. 506 Agroforestry **1+1** **Sem. II**

Agroforestry objectives, importance and potential. Farming system. Community forestry and social forestry. Agroforestry systems - perspectives, national and global importance. Choice and management of agroforestry. Practices for live fences, hedge rows, alley- cropping, windbreaks and shelter belts, hill-slope and terrace farming, and wood-lots. Diagnostic and design methodology. Tree-crop interface and resource utilization. Nutrient budgeting and soil productivity in agroforestry systems. Agroforestry under different productivity levels. Yield optimization and economics of agroforestry enterprise.

Practical: Field visits to agroforestry and farm forestry sites. Methods of planting trees with crops. Lay out of agroforestry trials. Measurement of growth and yield parameters of agroforestry components, and data analysis. Marketing and economic appraisal of agroforestry projects. Determination of litter fall. Root studies in agroforestry system.

Forst. 507/ Econ 520 Forest Resource Management and Economics **1+1** **Sem. I**

Importance of Forests, use of economic principles in forest resources problems. Forest products, demand and supply analysis, forest products marketing, forest capital theory. Inter-regional and international trade in forest products. Impact of economics and physical variables upon forest appraisal and management decisions. Externalities and property rights. Natural and environmental resource accounting -methods and implications. Application of operations research tools in evaluating forest management alternatives in public and private forest planning.

Practical: Exercises on estimation of demand and supply functions; biodiversity valuation, valuation of non-marketed forest products. Exercises on financial and economic appraisal of forestry projects. Exercises on marketing of forest products and international trade competitiveness. Computer applications for using programming techniques in evaluating forest management alternatives.

Forst. 508 Forest Policy, Laws and International Conventions **2+0** **Sem. I**

Forest policy - Relevance and scope; National Forest Policy - 1894, 1952 and 1988. General principles of criminal law; Indian Penal Code, criminal procedure code; Indian evidence act applied to forestry matters. Forest laws; Indian Forest Act -1927, the state amendments - Punjab and Haryana general provision and

detailed study; Forest Conservation Act 1980, Forest (conservation) Rule 2003, The Biological Diversity Act.2002. The Cattle Trespass Act 1871. The wildlife (protection) Licensing (additional matters for consideration) rules 1983. Declaration of wildlife stock rules 2003. Wildlife Protection Act 1972. Other important forest rules and guidelines. Important case studies and landmark judgments.

Forst. 509 Forests and People

2+0

Sem. I

Forest societies, people and forests interactions between forests and people. Importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management. Afforestation programmes and forest conflicts, wildlife and human conflicts, important forest movements like Chipko movement. Gender dimension of forest management. Pastoralists and their dependence on forests. Forests and economic security of tribals. Forests and food security, eco-tourism and local development, land use change and forestry. Forest rights, customary rights of people, community participation, ethnobotany, Joint Forest Management, global environmental change and land use, dams, forests and resettlement of tribals and non-tribals - case study. Poverty alleviation and forests, role of NGOs and other community based organizations in forest management.

Forst. 510 Forest Products - Chemistry and Industries

2+1

Sem. II

(Collaboration: Deptt. of Chemistry)

Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products. Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes. Minor forest products- gums, resins, essential oils and tannins, fibres, bamboos and canes. Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood-water and organic solvent soluble. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth). Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest based dyes and pigments.

Practical: Estimation of cell wall contents - Hemicellulose and lignin, extraction of essential oils, resins, tannins, acetylation of wood. Moisture content, specific gravity and calorific value determination of wood samples. Determination of strength properties of wood. Visit to nearby forest based industries. Visit to State Forest Corporation's saw mill and wood fabrication unit.

Forst. 591 Seminar

Forst. 600 Master's Research

FRUIT SCIENCE

PROGRAMMES

1. M. Sc.

2. Ph. D.

COURSE REQUIREMENTS

M. Sc.

Field of Specialization	Nursery Production, Fruit Production, Orchard Management, Horti.- Agro Techniques, Post- harvest Handling
Required Courses	Hort. 501, Hort. 502, Hort. 503, Hort. 504, Hort. 505
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem.
Minor Fields	Botany, Biochemistry, Biotechnology, Plant Breeding and Genetics, Soil Science, Vegetable Science or any other as approved by Dean, postgraduate Studies.
Deficiency Courses for Student's with elective other than Horticulture	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph. D.

Field of Specialization	Nursery Production, Fruit production, Orchard Management, Horti.- Agro Techniques, Post- harvest Handling
Required Courses	Hort. 601, Hort. 602, Hort. 603
Supporting Courses	Courses from subject matter fields (other than minor) relating to area of special interest and research problem.
Minor Fields	Botany, Biochemistry, Biotechnology, Plant Breeding and Genetics, Soil Science, Vegetable Science or any other as approved by Dean, postgraduate Studies.
Deficiency courses for students with M. Sc. (Agri.) in a discipline other than Pomology	Hort. 501, Hort. 502, Hort. 503, Hort. 504, Hort. 505 and other courses as recommended by Student's Advisory Committee

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Hort. 91 Horticulture-I	2+1	Sem. I
<p>Elements of Horticulture; types of fruits and vegetables; their economic importance and role in human nutrition; agro-climatic requirements; methods of propagation and cultural practices of important fruits and vegetables in the State; kitchen gardening; introduction to floriculture, landscape and gardening; annual and woody ornamentals.</p> <p>Practical: Identification of important fruits and vegetable crops/ species/ varieties; seed and soil sterilization; nursery raising of flowering annuals; vegetable and fruit crops; lay out system for kitchen gardening; planting of fruit trees; practices and propagation of fruit plants; training and pruning of fruit trees; visit to floriculture and landscaping area.</p>		

Hort. 203 Production Technology of Fruit Crops **2+1** **Sem. I**

Definition, importance and divisions of horticulture. Climatic zones, area and production of different fruit crops. Selection of site, fencing and wind break. Planting systems, high density planting, planning and establishment. Propagation methods and use of rootstocks. Methods of training and pruning. Use of growth regulators in fruit production. Package of practices for the cultivation of - Major fruits -mango, banana, citrus, grapes, guava, sapota, apple, litchi and papaya. Minor fruits - pineapple, annonaceous fruits, pomegranate, ber, fig, loquat, phalsa, jackfruit, pear, plum, peaches, apricot and cherry.

Practical: Horticultural tools and their uses. Containers and potting mixtures. Plant and seed propagation, scarification, and stratification. Layout and planting systems. Methods of pruning and training. Training of ber, grape and pomegranate. Pruning of ber, grape, phalsa, fig, apple, pear, peach. Identification of important species and varieties of fruits. Irrigation methods including drip and micro irrigation. Methods of fertilizer application. Preparation of growth regulators, powder, solution and lanolin paste for propagation. Application of growth regulators for improving fruit set, fruit size, quality, delaying and hastening ripening. Visit to local commercial orchards.

Hort. 301 Post-harvest Management of Fruits and Vegetables **1+1** **Sem. I**

(Collaboration : Department of Vegetable Science)

Importance. Maturity indices, harvesting and post harvest handling of fruits and vegetables. Maturity and ripening process. Factors affecting ripening and deterioration of fruits and vegetables. Chemicals used for delaying and hastening ripening. Methods of storage and low cost storage structures. Methods of packing, packaging materials and transport. Types of containers, cushioning material, vacuum packing, shrink packing, specific packing for export of mango, banana, grapes, Kinnow, sweet orange, and mandarin etc. Unit layout - selection of site and precautions for hygienic conditions.

Practical: Judging maturity of various fruits and vegetables. Conservation of zero energy cool chambers for on farm storage. Determination of physiological loss in weight, total soluble solids, total sugars, acidity and ascorbic acid content in fruits and vegetables. Types of packing and importance of ventilation. Pre cooling of horticultural crops. Methods of prolonging storage life. Effect of ethylene on ripening of fruits. Identification of equipments and machinery used in preservation of fruits and vegetables. Preservation by drying and dehydration. Visit to local market yards, cold storage units and packing house.

Undergraduate Elective/M.Sc. Supporting/Minor Courses

Hort. 433 Nursery Management of Horticultural Crops **2+1** **Sem. I**

Principles of plant propagation. Seed dormancy and germination. Selection of rootstock and scion. Stock scion relationship. Factors affecting successful propagation. Physiology of dwarfing rootstock. Different methods of propagation like division, cutting, layering, budding and grafting, and tissue culture. Containers, media and mixtures. Propagation structures. Nursery act, quarantine and certification. Nutrient management and plant protection measures in nursery. Economics of raising fruit plant nursery.

Practical: Raising of rootstock. Methods to break seed dormancy. Propagation techniques. Training, lifting and packing of nursery plants. Preparation of media and mixtures, and raising nursery in poly bags. Project formulation and valuation of nursery raising.

Hort. 434 Commercial Fruit Production **2+1** **Sem. I**

Importance and uses, botany, flowering and fruiting, climate and soil, promising varieties, horti- agri techniques, production, plant protection measures and special problems in fruits such as citrus, mango, guava, apple, pear, peach, plum, ber, litchi, grapes, pomegranate, papaya, pineapple, phalsa, banana and sapota.

Practical: Identification of species and fruit varieties, training and pruning, maturity standards, harvesting, handling, grading and packing of fruits. Project formulation and valuation of orchard management.

Hort. 435 Processing and Value Addition of Horticultural Crops **2+1** **Sem. I**

(In collaboration with Department of Food Science and Technology)

Scope of fruit preservation industry in India, present status, constraints and prospects. Importance, principles and practices of fruit processing. Maturity indices, harvesting, transportation and quality

parameters of fruits. Pre and post harvest factors affecting processing quality of fruits. Commercial processing technologies for fruits like mango, citrus, guava, grapes, ber, apple, pear, peach, plum, phalsa, litchi, pomegranate and papaya etc. Packing technology for export and value addition.

Practical: Judging of maturity of different fruits. Methods of preparation of jam, jelly, ready to serve, squash, nectar, canning, chutteny, pickle and marmalade etc. Packing technologies. Drying and dehydration of fruits. Visit to local processing unit.

Postgraduate Courses

Hort. 501 Tropical and Dry Land Fruit Production **2+1** **Sem. I**

Origin, distribution, commercial importance and export potential. Ecophysiological requirements. Species and varieties. Rootstocks and propagation. Planting, root zone, training and pruning. Nutrition and water requirements, fertigation, role of bio- regulators, major pests, diseases, physiological disorders and their control measures. Abiotic factors limiting fruit production. Flowering, pollination and fruit set. Quality improvement. Storage and ripening techniques. Industrial and export potential, Agri. Export Zones (AEZ) and industrial support. Fruit crops- citrus, mango, papaya, pineapple, banana, avocado, sapota, guava, ber, amla, Jack fruit, annonas and minor fruits of tropics.

Practical: Description and identification of species and varieties. Growth and development. Growth regulation. Nutritional and physiological disorders and their control. Rejuvenation of old and unproductive trees. Visit to commercial orchards. Project preparation for establishing commercial orchards..

Hort. 502 Sub-tropical and Temperate Fruit Production **2+1** **Sem. II**

Origin, distribution, commercial importance and export potential. Ecophysiological requirements. Species and varieties. Rootstocks and propagation. Planting, root zone, training and pruning. Nutrition and water requirements, fertigation, role of bio- regulators, major pests, diseases, physiological disorders and their control measures. Abiotic factors limiting fruit production. Flowering, pollination and fruit set. Quality improvement. Storage and ripening techniques. Industrial and export potential, Agri. Export Zones (AEZ) and industrial support. Fruit crops- Apple, pear, quince, grapes, plum, peach, apricot, cherries, hazelnut, litchi, loquat, persimmon, kiwifruit, strawberry, walnut, almond, pistachio, pecan, mangosteen, carambola, bael, wood apple, fig, jamun, rambutan and pomegranate.

Practical: Description and identification of species and varieties. Growth and development. Growth regulation. Nutritional and physiological disorders and their control. Rejuvenation of old and unproductive trees. Visit to commercial orchards. Project preparation for establishing commercial orchards.

Hort. 503 Nutrient and Canopy Management in Fruit Crops **2+1** **Sem. II**

Essential elements, criteria of essentiality. Natural sources and fertilizers. Role of essential elements in fruit plants. Interaction of nutrients. Canopy management, importance and advantages. Factors affecting canopy development. Canopy types and structures. Light interception and distribution in different types of tree canopies. Spacing and utilization of land area. Canopy management through the use of rootstock and scion, plant growth inhibitors, training and pruning and management practices. Canopy development in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, pomegranate, mango, sapota, guava, citrus and ber.

Practical: Leaf sampling techniques, Determination of nutrient status through soil and plant analysis. Study of different types of canopies. Training of plants for different canopy types. Canopy development through pruning, use of plant growth inhibitors and, geometry of planting. Effect of canopy types on production and quality of fruits.

Hort. 504 Principles and Practices of Plant Propagation. **2+1** **Sem. II**

Introduction, life cycles in plants, cellular basis for propagation. Sexual propagation- apomixis, polyembryony, chimeras. Factors influencing seed germination, hormonal regulation of germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing. Rooting of cuttings under mist and hot beds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Selection of elite mother plants. Establishment of bud wood bank. Stock, scion and inter stock relationship and Incompatibility. Physiology of dwarfing rootstocks. Rejuvenation. Progeny orchard and

scion bank. Micro-propagation - in vitro clonal propagation, direct organogenesis, embryogenesis, micrografting and meristem culture. Hardening, packing and transport of micro-propagules. Nursery structures.

Practical: Anatomical studies in rooting of cutting and graft union. Propagation structures. Use of media and PGR. Micropropagation and hardening of plants. Explant preparation, media preparation, culturing in vitro, clonal propagation, meristem culture, shoot tip culture, axillary bud culture., Micro grafting and hardening. Visit to TC labs and nurseries.

Hort. 505 Breeding of Fruit Crops

2+1

Sem. I

Origin and distribution, taxonomical status of species and cultivars. Cytogenetics and genetic resources. Blossom biology, breeding objectives, systems and ideotypes. Crop improvement through introduction, selection, hybridization, mutation breeding, polyploid breeding and rootstock breeding. Improvement of quality traits. Resistance breeding for biotic and abiotic stresses. Biotechnological interventions, achievements and future thrust. The important temperate, sub-tropical and tropical fruit crops will be covered.

Practical: Characterization of germplasm. Blossom biology and anthesis. Estimating fertility status. Practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical and quality traits. Screening for resistance, developing breeding programme for specific traits. Visit to research stations.

Hort. 506 Post-harvest Technology for Fruit Crops

2+1

Sem. II

Importance and scope. Maturity indices, harvesting practices and grading for specific market requirements. Influence of pre-harvest practices, enzymatic and textural changes, respiration and transpiration. Physiology and biochemistry of fruit ripening, ethylene evolution and its management. Pre-cooling. Factors leading to post-harvest losses. Treatments prior to transportation viz. chlorination, waxing, chemicals, bio-control agents, natural plant products fungicides, hot-water, vapour heat treatment, sulphur fumigation and irradiation. Methods of storage. Physical injuries and disorders during storage. Packing methods and transport. Quality evaluation.

Practical: Analyzing maturity stages of commercially important fruit crops, harvesting methods, pre-cooling methods, grading. Pre-harvest and post-harvest application of growth substances, fungicides, nutrients, waxes and hot water treatments, sulphuring. Improved packing and storage of important horticultural commodities. Physiological loss in weight of fruits. Estimation of transpiration, respiration rate, ethylene release. Estimation of quality characteristics in stored fruits. Cold chain management - visit to cold storage and CA storage units. .

Hort. 507 Growth and Development of Horticultural Crops

2+1

Sem. I

(In collaboration with Department of Botany)

Parameters of growth and development. Growth dynamics and morphogenesis. Annual, semi-perennial and perennial fruit crops. Effect of light and temperature. Assimilate partitioning during growth and development. Effect of water and mineral nutrition. Biosynthesis and role of growth promoters and inhibitors. Physiology of dormancy, bud break, juvenility, vegetative to reproductive inter phase, flowering, pollination, fertilization, fruit set, fruit drop, fruit growth, ripening and seed development. Growth and developmental processes during stress. Impact of pruning, training and chemical manipulations in fruit crops.

Practical: Dormancy mechanisms and stratification of seeds. Visit to different fruit zones to identify growth and development patterns. Techniques of growth analysis. Evaluation of photosynthetic efficiency. Study of growth regulator functions, hormone assays and ripening phenomenon in fruits. Stress impact on growth and development.

Hort. 508 Orchard Management and Organic Horticulture

2+1

Sem. I

Soil quality and its management for orchard plantation. Effect of soil organic matter on physico-chemical characteristics of the soil. Moisture conservation and water requirement for fruit crops. Principles, methods and scheduling of irrigation. Principles and status of organic horticulture. Organic farming systems. Organic inputs and their role. EM technology and its impact. Indigenous practices of organic farming, sustainable soil fertility, weed management and biological/natural control of pests and diseases. Fruit quality improvement. Good Agricultural Practices (GAP), HACCP and certification of organic products. Standards evolved by different agencies. Constraints in certification, organic horticulture and export.

Practical: Different methods of irrigation. Mulching and weed control in orchards. Determination of soil organic matter. Inter-cropping exercises. Input analysis of manures. Bio-composting, biofertilizers and their application. Methods of preparation of organic manures. EM technology and products. Biological/ natural control of pests and diseases. soil solarization. Case studies. Residue analysis in organic products and documentation.

Hort. 601 Advances in Breeding of Fruit Crops (pre- requisite Hort. 505) 3+0 Sem. I

Evolutionary mechanisms, adaptation and domestication. Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern. Variations and natural selection, spontaneous mutations, incompatibility systems in fruits. Recent advances in crop improvement through introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses. Breeding for improving quality. Molecular and transgenic approaches in improvement of selected fruit crops: Mango, banana, papaya, grapes, citrus fruits, guava, sapota, pineapple, avocado, apple, pear, plums, peaches, apricot, cherries and strawberry.

Hort. 602 Advances in Production of Fruit Crops 3+0 Sem. II

National and international scenario. Advances in propagation, root stock problems and their influence, planting systems, High density planting and crop modeling. Precision farming. Aspects of crop regulation. Influence of stress factors, strategies to overcome stress effects. Integrated water and nutrient management. Total quality management of mango, banana, papaya, grapes, citrus. guava, sapota, pomegranate, amla, pineapple, avocado, jack fruit , fig, apple, pear, plum, strawberry, peach, apricot, cherries and nut crops.

Hort. 603 Advances in Growth Regulation of Fruit Crops 3+0 Sem. II

Ecophysiological influences on growth and development like flowering, fruit set, crop load and assimilate partitioning and distribution. Root and canopy regulation. 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. Canopy management for fertigated orchards. Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy. Fruit bud initiation, flowering, off season production. Flower drop and thinning, fruit set and development, fruit drop, parthenocarpy, fruit maturity, ripening and storage. Molecular approaches in crop growth regulation.

Hort. 604 Advances in Nutrition of Fruit Crops 3+0 Sem. I

Historical background. Organic and inorganic sources. Nutrition and plant health - role of macro, secondary and micro nutrients. Nutrient status of different types of soils. Mineral uptake and translocation - theories and mechanisms. Nutritional problems of saline, sodic and water logged soils and their solutions. Inter-relationships of elements of fruit plants. Deficiency and toxic nutrient symptoms. Nutritional disorders in fruits. Fertilizer needs, scheduling, foliar feeding and fertigation. Bio fertilizers- role and classification. Integrated nutrient management in fruit crops.

Hort. 605 Biotic and Abiotic Stress Management in Fruit Crops. 3+0 Sem. I

Stress-definition and classification. Biotic stress due to pathogens like fungi, bacteria, viruses and nematodes. Stresses due to water, temperature, radiation, wind and soil conditions. Impact of stress on horticultural crop production. Stress due to physiological and biochemical factors. Fruit crops suitable for different stress situations. Crop modeling for stress situations. Interaction among different stress and their impact on crop growth and productivity. Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs. Soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency. Contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Hort. 591 Seminar

Hort. 600 Master's Research

Hort. 700 Ph.D. Research

PLANT BREEDING AND GENETICS

PROGRAMMES:

1. M. Sc.

2. Ph. D.

COURSE REQUIREMENT

M. Sc.

Field of Specialization

Plant Breeding, Genetics, Cytogenetics

Required Courses

PBG 501, PBG 502, PBG 503, PBG 504 and PBG 505

Supporting Courses

Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) related to area of special interest and research problem.

Minor Fields

Biotechnology, Statistics, Plant Pathology, Entomology, Botany, Biochemistry, Microbiology, Agronomy or any other as approved by the Dean, postgraduate Studies

Deficiency courses for students with elective other than Plant Breeding, Genetics and Biotechnology

9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization

Plant Breeding, Genetics, Cytogenetics

Required courses

PBG 601, PBG 602, PBG 603

Supporting Courses

Courses from subject matter fields (other than minor) related to area of special interest and research problem.

Minor Fields

Biotechnology, Statistics, Plant Pathology, Entomology, Botany, Biochemistry, Microbiology, Agronomy or any other as approved by the Dean, postgraduate Studies.

Deficiency courses for students with M. Sc. in discipline other than Plant Breeding and Genetics

PBG 501, PBG 502, PBG 503, PBG 504, PBG 505 and other courses as recommended by Student's Advisory Committee

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

PBG 102 Introductory Genetics

2+0

Sem. I

(For College of Home Science)

Ultra structure of cell, cell organelles and their functions. Cell division and its significance. Mendel's law of inheritance. Type of gene interactions. Multiple allelism/blood group/Rh incompatibility. Chromosome structure, morphology, number and types. DNA and RNA, their structure and function. Replication and transcription. Outline of protein synthesis. Genetic code, definition and properties. Mutations and its applications. Genetic counseling. Genetic disorders in man. Genetics and human welfare.

PBG 103 Introduction to Genetics

2+1

Sem. I

Mendel's laws of inheritance and exceptions to the laws, Types of gene action, Multiple alleles, Pleiotropism, Penetrance and expressivity; Qualitative traits, Quantitative traits and differences between them; Multiple factor hypothesis; Cytoplasmic inheritance, its characteristic features and difference between chromosomal and cytoplasmic inheritance; Mutation and its characteristic features; Methods of inducing mutations and detection of sex linked and autosomal mutations, CIB technique. Gene expression and differential gene activation; Lac operon and fine structure of gene; Ultra structure of cell, cell organelles and their functions; Study of chromosome structure, morphology, number and types. Karyotype and idiogram; Mitosis and meiosis, their significance and differences between them; DNA and its structure, function, types, modes of replication and repair. RNA and its structure, function and types; Transcription, Translation. Genetic code and outline of protein synthesis; Crossing over and factors affecting it; Mechanism of crossing over and Cytological proof of crossing over; Linkage, types of linkage and estimation of linkage; Numerical chromosomal aberrations (Polyploidy) and evolution of different crop species like cotton, wheat, tobacco, triticale and Brassicas; Structural chromosomal aberrations.

Practical: Microscopy (Light microscopes and electron microscopes; Preparation and use of fixatives and stains for light microscopy; Preparation of micro slides and identification of various mitosis and meiosis; Monohybrid, Dihybrid and Trihybrid ratios and their modifications; Chi-square analysis and Interaction of factors; Epistatic factors, Supplementary factors and Duplicate factors; Complementary factors, Additive factors and Inhibitory factors; Linkage - Two point test cross; Linkage - Three point test cross; Induction of polyploidy using colchicine; Induction of chromosomal aberrations using chemicals.

PBG 202 Principles of Seed Technology

2+1

Sem. II

Introduction of Seed Production. Importance of Seed Production. Seed policy. Seed demand forecasting and planning for certified, foundation and breeder seed production. Deterioration of crop varieties. Factors affecting deterioration and their control; Maintenance of genetic purity during seed production, Seed quality; Definition, Characters of good quality seed. Different classes of seed. Production of nucleus and breeder seed. Maintenance and multiplication of pre-release and newly released varieties in self and cross-pollinated crops; Seed Production. Foundation and certified seed production in maize (varieties, hybrids, synthetics and composites). Foundation and certified seed production of rice (varieties and hybrids). Foundation and certified seed production of sorghum and bajra (varieties, hybrids, synthetic and composites); Foundation and certified seed (varieties and hybrids) production of castor, tomato, brinjal, chillies, bhindi, onion, bottle gourd and ridge gourd. Seed certification. Phases of certification, procedure for seed certification, field inspection and field counts etc. Seed Act and its enforcement. Central Seed Committee. Central Seed Certification Board. State Seed Certification Agency. Central and State Seed Testing Laboratories; Duties and powers of seed inspectors, offences and penalties; Seed control order, Seed control order 1983, Seed Act 2000 and other issues related to seed quality regulation. Intellectual Property Rights. Patenting, WTO, Plant Breeders Rights. Varietal Identification through grow-out test and Electrophoresis; Seed Drying; Forced air seed drying principle, properties of

air and their effect on seed drying, moisture equilibrium between seed and air. Heated air drying, building requirements, types of air distribution systems for seed drying, selection of crop dryers and systems of heated air drying, recommended temperature, management of seed drying. Planning and layout of seed processing plant. Establishment of seed processing plant. Seed processing, air-screen machine and its working principle, different upgrading equipments and their use. Establishing a seed testing laboratory. Seed testing procedures for quality assessment. Seed treatment. Importance of seed treatment, types of seed treatment, equipment used for seed treatment (slurry and Mist O-matic treater). Seed packing and seed storage, stages of seed storage, factors affecting seed longevity during store and conditions required for good storage. General principles of seed storage, constructional features for good seed warehouse, measures for pest and disease control, temperature control. Seed marketing, marketing structure, marketing organization, sales generation activities, promotional media, pricing policy and factors affecting seed marketing. Practical: Seed sampling principles and procedures; Physical purity analysis of field and horticultural crops; Germination analysis of field and Horticultural Crops; Moisture tests of Field and Horticultural crops; Viability test of field and horticultural crops; Seed health test of field and horticultural crops; Vigour tests of field and horticultural crops; Seed dormancy and breaking methods; Grow-out tests and electrophoresis for varietal identification ; Visit to seed production plots of maize; sunflower, bajra, rice, wheat, sorghum, cotton, chillies and vegetables. Visit to seed processing plants, seed testing laboratories, grow-out testing farms and hybrid seed production farms. Varietal identification in seed production plots, planting ratios, isolation distance and rouging etc.

PBG 303 Introduction to Plant Breeding

2+1

Sem. I

Classification of plants, botanical description, floral biology, emasculation and pollination techniques in cereals, millets, pulses, oilseeds, fibers, plantation crops etc. Aims and objectives of Plant Breeding; Modes of reproduction- sexual, asexual, apomixis; Significance in plant breeding; Modes of pollination, genetic consequences, differences between self- and cross- pollinated crops; Methods of breeding - Introduction and Acclimatization; Selection, mass Selection, Johannsen's pure-line theory, genetic basis, pure-line selection; Hybridization, aims and objectives, types of hybridization; Methods of handling segregating generations, pedigree method, bulk method, back cross method; Incompatibility and male sterility and their utilization in crop improvement; Heterosis, inbreeding depression, various theories of heterosis, exploitation of hybrid vigor, development of inbred lines, single-cross and double-cross hybrids; population improvement programmes, recurrent selection, synthetics and composites; Methods of breeding vegetatively propagated crops, clonal selection; Mutation breeding; Ploidy breeding; Wide hybridization and its significance in crop improvement.

Practical: Botanical description and floral biology; Study of megasporogenesis and microsporogenesis. Fertilization and life cycle of an angiospermic plant; Plant Breeder's kit: Hybridization techniques and precautions to be taken; Floral morphology, selfing, emasculation and crossing techniques; Study of male sterility and incompatibility; Field crops: rice, sorghum, maize, wheat, bajra, sugarcane, brassicas, groundnut, sunflower, sesamum, red gram, bengal gram, green gram, soybean, black gram, cotton, chillies, brinjal, tomato, bhindi, onion and bottle gourd.

PBG 304 Breeding of Field and Horticultural Crops

2+1

Sem. II

(Collaboration: Department of Floriculture and Landscaping , Fruit Science and Vegetable Science)

Breeding objectives and important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops; Hardy-Weinberg Law; Study in respect of origin, distribution of species, wild relatives and forms, Cereals, (rice, wheat, maize, millets, sorghum, bajra); Pulses (red gram, green gram, black gram, soybean); Oilseeds (Groundnut, sesame, sunflower, brassicas) etc, Fibres (Cotton) etc, Vegetables (Tomato, bhindi, chilli, cucumbers); Flowers crops (Chrysanthemum, rose, gaillardia and marigold); Fruit crops (amla, guava, mango, banana, papaya); Major breeding procedures for development of hybrids/varieties of various crops; Plant genetic resources, their conservation and utilization in crop improvement; Ideotype concept in crop improvement; Breeding for resistance to biotic and abiotic stresses. Variability in pathogens and pests; Mechanisms of resistance in plant to pathogens and pests; Genetic basis of adaptability to unfavourable environments; Definition of biometrics, assessment of variability i.e.,

additive, dominance and epistasis and their differentiation; genotype x environment interaction and influence on yield/performance. IPR and its related issues.

Practical: Emasculation and Hybridization techniques; Handling of segregating generations-pedigree method, bulk method, back cross methods; Field layout of experiments; Field trials, maintenance of records and registers; Estimation of heterosis and inbreeding depression; Estimation of heritability; GCA and SCA; Estimation of variability parameters; Parentage of released varieties/hybrids; Problems on Hardy-Weinberg Law; Study of quality characters; Sources of donors for different characters; Visit to seed production and certification plots; Visit to AICRP trials and programmes; Visit to grow-out test plots; Visit to various research stations; Visit to other institutions.

Undergraduate Elective/M.Sc. Supporting/Minor Courses

PBG 433 Genetics of Crop Plants 2+1 Sem.I

Genetic analysis in different systems. Genetic recombination in prokaryotes and eukaryotes. Detection and estimation of linkage from test cross and F2 data. Genetic material - organization, structure and replication. Extra nuclear inheritance. Genetic of quantitative traits. Genetic equilibrium and forces changing gene frequency. Induction, detection and uses of mutations. Gene function. Gene expression. Gene regulation. Environmental influence on gene expression. Gene cloning. Genetic transformation.

Practical: Study of autosomal monogenic and digenic inheritance. Three point test cross and gene mapping. Detection and estimation of linkage using test cross and F2 data. Segregation in corn. Gene frequency analysis - autosomal, sex-linked and multiple allelic traits. Genetic equilibrium. Demonstration of quantitative inheritance.

PBG 434 Cytogenetics of Crop Plants 2+1 Sem.I

Structure and function of cell organelles. Chromosomal theory of inheritance. Morphology, ultra structure and differential staining of chromosomes. Unusual chromosomes. Cell cycle. Cytological, genetic and morphological effects of chromosomal aberrations. Classification, induction, characterization and utilization of haploids, euploids and aneuploids. In situ hybridization. Evolution of karyotype. Genome analysis in wheat, cotton, Brassica species. Practical: Microscopy. Techniques of cytological preparations. Fixation of material for mitosis

and meiosis. Preparation of permanent slides of cell division. Karyotype analysis. Production and study of polyploids and haploids. Identification of aneuploids.

PBG 435 Theory and Practice of Plant Breeding 3+1 Sem.I

Role of plant breeding. Centres of origin of crop plants. Plant genetic resources and their utilization. Breeding systems. Breeding methods in self-pollinated, cross-pollinated and vegetatively propagated crops and their genetic basis. Heterosis and its exploitation. Male sterility and self-incompatibility. Mutation and polyploidy. Breeding for quality traits. Breeding for abiotic and biotic stresses. Wide hybridization. Procedures for the release of new varieties. Plant breeding for sustainable agriculture. Plant Variety Protection and Breeders' Rights. Practical: Emasculation, crossing and selfing in various crops. Collection, viability and germination of pollen. Handling of breeding materials. Study of variability, male sterility and self-incompatibility. Quality testing in crop plants. Screening for disease resistance.

PBG 436 Introduction to Breeding of Field Crops 3+0 Sem.I

Application of genetic, cytogenetic and biotechnological techniques in breeding of wheat, triticale, rice, maize, bajra, barley, sorghum, cotton, sugarcane, important pulses, oilseeds and forage crops including their origin and germplasm sources. Problems and present status of crop improvement in India with emphasis on the work done in Punjab. National and International centres of crop improvement.

PBG 437 Crop Experimentation 1+1 Sem. I

Experiments in Plant Breeding - objectives, analysis and interpretation of results. Statistics in relation to crop experimentation. Principles of experimental designs. Uniformity trials, progeny rows trials, compact family block design, completely randomized block design, randomized block design, incomplete block

designs. Simple lattice. Augmented designs. Varietal trials over years and locations. G x E and estimation of genetic components. Analysis of co-variance. Determination of yield through its components.

Practical: Statistical parameters and tests of significance. Use of computer packages for analysis. Layout of field experiments. Analysis of experimental designs. Character association. Analysis of varietal trials and G x E interactions.

Postgraduate Courses

PBG 501 Principles of Genetics

2+1

Sem. I

History of genetics. Multiple alleles and Gene interactions. Sex determination, differentiation and sex-linkage. Linkage-detection. Recombination and genetic mapping in eukaryotes. Extra chromosomal inheritance. Hardy-Weinberg equilibrium. Nature, structure and replication of the genetic material. Genetic code. Protein biosynthesis. Genetic fine structure analysis, allelic complementation, split genes, transposable elements, overlapping genes, pseudogenes, oncogenes, gene families and clusters. Regulation of gene activity in prokaryotes and eukaryotes. Molecular mechanisms of mutation, repair and suppression. Bacterial plasmids. Molecular chaperones. Gene isolation, synthesis and cloning. Genomic and cDNA libraries, nucleic acid hybridization and immunochemical detection. DNA sequencing. DNA restriction and modification, Anti-sense RNA and ribozymes. Micro-RNAs. Genomics and proteomics. Functional and pharmaco genomics. Metagenomics. Study of polymorphism at biochemical and DNA level. Transgenics and bioethics. Gene silencing. Concepts of Eugenics, epigenetics, genetic disorders and behavioural genetics.

Practical: Laboratory exercises in probability and chi-square. Demonstration of genetic principles using laboratory organisms. Chromosome mapping using three point test cross. Tetrad analysis. Induction and detection of mutations through genetic tests. DNA extraction and PCR amplification. Electrophoresis. 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.

PBG 502 Principles of Cytogenetics

2+1

Sem. II

Architecture of chromosome in prokaryotes and eukaryotes. Artificial chromosomes and special types of chromosomes. Cell Cycle, synaptonemal complex, recombination models. Karyotyping. Chromosome banding and in situ hybridization. Structural variations of chromosomes and their implications. Variation in chromosome behaviour. Evolutionary significance of chromosomal aberrations. Polyploidy and its role in crop breeding. Aneuploidy and its role in basic and applied aspects of crop breeding. Apomixis. Genome mapping. Wide hybridization, Chromosome manipulations. Alien addition and substitution lines. Production and use of haploids and doubled haploids in genetics and plant breeding.

Practical: Learning the cytogenetics laboratory. Microscopy. Use of Electron microscope. Fixatives and fixing specimens. Studies on mitosis and meiosis in selected crops. Use of micrometers. Pollen germination in vivo and in vitro. Microtomy. Induction of polyploidy and identification in different crops. Induction and identification of haploids. Morphological and cytological observations on synthesized autopolyploids and allopolyploids. Morphological and cytological observations on aneuploids. Cytogenetic analysis of interspecific and intergeneric crosses. Maintenance of Cytogenetic stocks. Fluorescent in situ hybridization (FISH), Genomic in situ hybridization (GISH).

PBG 503 Principles of Plant Breeding

2+1

Sem. I

History of Plant Breeding, objectives and achievements. Centres of origin, biodiversity and its significance. Plant introduction and role of plant genetic resources in plant breeding. Genetic basis of breeding self- and cross-pollinated crops, Mating systems and response to selection. Pure line theory. Breeding methods in self-, cross-pollinated and asexually reproducing crops. Heterosis and inbreeding. Concept of plant ideotype. Transgressive breeding. Hybrid breeding. Self-incompatibility and male sterility in crop plants and their commercial exploitation. Mutation breeding. Breeding for abiotic and biotic stresses. Testing, release and notification of varieties. Maintenance breeding. Participatory Plant Breeding. Plant Breeders' Rights and regulations for plant variety protection and farmers' rights.

Practical: Floral biology of self- and cross-pollinated species. Selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material. Maintenance of experimental

records. Estimation of heterosis and inbreeding depression. Techniques in hybrid seed production using male-sterility in field crops.

PBG 504 Principles of Quantitative Genetics

2+1

Sem. II

Mendelian traits vs polygenic traits. Quantitative traits and their inheritance. Multiple factor hypothesis. Nature of gene action, epistatic and linkage effects. Analysis of Variance and variance components. MANOVA. Biplot analysis. Comparison of means and variances for significance. Designs for experiments. Genetic diversity analysis. Association analysis. Path analysis and parent-progeny regression analysis. Discriminant function and principal component analyses. Selection indices. Heritability and genetic advance. Generation mean analysis. Mating designs. Genotype x environment interaction. Stability parameters. AMMI analysis - principles and interpretation. QTL mapping. Marker assisted selection (MAS).

Practical: Multiple factors inheritance. Partitioning of variance. Heritability and genetic advance. Covariance analysis. Metroglyph analysis. D2 analysis, cluster diagrams and dendrograms. Correlation analysis. Path analysis. Parent-progeny regression analysis. Diallel analysis. NCD. Line x tester analysis. Generation mean analysis. QTL mapping. Bi-parental mating and Triple Test Cross Stability analysis. AMMI model. Principal component analysis. Biplots and mapping genotypes. Construction of saturated linkage maps.

PBG 505 Heterosis Breeding

2+1

Sem. II

Historical aspect of heterosis. Genetic theories of heterosis. Physiological, biochemical and molecular factors underlining heterosis. Prediction of heterosis. Development of heterotic pools in germplasm and inbreds. Male sterility and its use in heterosis breeding. Use of self-incompatibility in development of hybrids. Hybrid seed production system. Male sterile line development and diversification. Apomixis and heterosis. Genetically engineered male-sterility. Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops. Hybrid breeding at National and International level.

Practical: Male sterile line development and characterization in different crops. Restorer line identification and diversification of male sterile sources. Breeding apomicts. Estimation of heterotic parameters in self-, cross- and asexually propagated crops. Hybrid seed production in field crops. Future prospects.

PBG 506 Mutagenesis and Mutation Breeding

1+1

Sem. I

History of mutation breeding. Nature and classification of mutations. Spontaneous mutations. Detection of mutations in lower and higher organisms. Para-mutations. Physical and chemical mutagens and mode of action. Dose determination and factors influencing mutagenesis. Effect of mutations on DNA and repair mechanisms. Treatment methods. Observing mutagen effects in M1, M2, M3 generation. Factors influencing the mutant spectrum. Comparative evaluation of physical and chemical mutagens. Use of mutagens in creating oligogenic and polygenic variations - case studies. In vitro mutagenesis. Validation of mutants. Mutation breeding for various traits in different crops. Achievements of mutation breeding. Problems associated with mutation breeding. Use of mutagens in genomics. Allele mining and TILLING.

Practical: Mutagenic agents. Visit to radio isotope laboratory. Treating the plant propagules at different doses of physical and chemical mutagens. Raising the crop for observation- Study of M1, M2 generation - Parameters to be observed. Mutation breeding in cereals, pulses, oilseeds, cotton, forage crops and vegetatively propagated crops. Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

PBG 507 Population Genetics

2+1

Sem. II

Properties of population. Genetic constitution of a population. Mating systems. Frequencies of genes and genotypes and causes of changes. Hardy-Weinberg law and its applications. Multiple alleles. Sex linked genes. Use of gene and genotypic frequencies. Recurrent and non-recurrent selection. Selection favouring heterozygotes - overdominance for fitness. Non random mating. Selfing, sibmating, assortative and disassortative mating. Pedigreed populations. Estimation of selection, disequilibrium and linkage. Gene substitution and average effect. Genetic drift. Co-adapted gene complexes. Homeostasis. Adaptive organization of gene pools: polymorphism, heterozygous advantage - survival of recessive and deleterious alleles in populations.

Practical: Genetic exercise on probability. Estimation of gene frequencies. Factors affecting gene frequencies. Estimation of average affect of gene substitution and breeding value. Inbreeding and linkage disequilibrium.

Cavalli's joint scaling test. Mating designs. Estimation of different population parameters from experimental data. Measurement of genotype x environment interaction. Genetic divergence.

PBG 508 Cell Biology and Molecular Genetics

2+1

Sem. II

Ultrastructure of eukaryotic, prokaryotic cells and cellular organelles. Interphase nucleus- structure and chemical composition. Physiology of cell division. Historical background of molecular genetics. Structure and properties of nucleic acids. DNA transcription and its regulation. Genetic code. Regulation of protein synthesis in prokaryotes and eukaryotes. Transposable elements. Mechanisms of recombination in prokaryote. DNA organization in eukaryotic chromosomes. Organelle genomes. Gene amplification and its significance. Proteomics and protein-protein interaction. Signal transduction. Genes in development. Cancer and cell aging.

Practical: Morphological and gram staining of natural bacteria. Cultivation of bacteria in synthetic medium. Determination of growth rate and doubling time of bacterial cells in culture. Demonstration of bacteriophage by plaque assay method. Determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium. Biological assay of bacteriophage and determination of phage population in lysate. Study of lytic cycle of bacteriophage by one step growth experiment. Determination of latent period and burst size of phages per cell. Quantitative estimation of DNA, RNA and protein in an organism.

PBG 509 Breeding for Biotic and Abiotic Stress Resistance

2+1

Sem. II

Plant breeding with reference to biotic and abiotic stress resistance. Biotic stresses in economically important crops. Host defense responses to pathogen invasions. Biochemical and molecular mechanisms. Host-pathogen interactions. Gene-for-gene hypothesis. Acquired and induced immunity. Systemic acquired resistance (SAR). Concept of signal transduction and other host-defense mechanisms against viruses and bacteria. Types and genetic mechanisms of resistance to biotic stresses. Phenotypic screening methods for major pests and diseases. Gene pyramiding. Classification of abiotic stresses - moisture stress/drought, water logging and submergence, wind, acidity, salinity/alkalinity/sodicity, temperature etc. Stress due to soil factors and mineral toxicity. Physiological and phenological responses. Genetics of abiotic stress resistance. Genes and genomics in breeding for abiotic stresses. Utilizing MAS procedures. Breeding for resistance to abiotic stresses. Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops. Transgenics in management of biotic and abiotic stresses. Practical: Phenotypic screening techniques for sucking pests, chewing pests, nematodes and borers. Use of standard MAS procedures. Phenotypic screening methods for diseases caused by fungi and bacteria. Screening crops for drought, flood resistance, acidity, alkalinity and temperature etc.

PBG 510 Breeding Field Crops

3+1

Sem. II

Evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics, genome relationship, breeding objectives, achievements and hybrid breeding in wheat, rice, maize, sugarcane, forage legumes, chickpea, other pulses, groundnut, rapeseed and mustard, sunflower, soybean and cotton. Distinguishing features of popular released varieties in rice, wheat, maize, sugarcane, pulses, oilseeds and cotton and their application to DUS testing. Maintenance of seed purity and seed production.

Practical: Floral biology. Emasculation - pollination techniques. Study of variation for yield and yield components. Study of segregating populations and their evaluation. Trait based screening for stress resistance in crops of importance. Use of descriptors for cataloguing. Germplasm maintenance. Standard evaluation system (SES) and descriptors. Use of softwares for database management and retrieval. Laboratory analysis of forage crops for crude protein, palatability, digestibility percent and other quality attributes. Wide hybridization in different crops. Visit to animal feed producing factories.

PBG 511 Breeding for Quality Traits

2+1

Sem. II

Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, amino acids and anti-nutritional factors. Nutritional improvement. Breeding for grain quality parameters in rice, golden rice and aromatic rice, wheat, barley, oats, maize, forage crops, pulses, cotton, groundnut, rapeseed mustard, sesame and sunflower. Breeding strategies for quality traits. Molecular and cytogenetic manipulation for quality. Post harvest manipulations. Molecular basis of fat formation and manipulation to achieve more

PUFA in oil crops. Genetic engineering protocols for quality improvement. Nutritional genomics. Second generation transgenics and achievements.

Practical: Grain quality evaluation in rice. Correlating ageing and quality improvement in rice. Quality analysis in millets. Estimation of anti-nutritional factors. Quality parameters evaluation in wheat, cotton, pulses and oilseeds. 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.

PBG 512 Gene Regulation and Expression **2+0** **Sem. I**

Gene regulation in prokaryotes and eukaryotes. Levels of gene controls. Coordinated genetic regulation. Genetic and molecular basis depending on tissue specificity. Gene expression. Light regulated gene expression. Para-mutations and imprinting of genes and genomes. Transgene expression and gene silencing mechanisms. Regulatory genes. Transformation. Reporter systems. Combinatorial gene control. Eukaryotic transcriptional control. Translational and post-translational regulation. Signal transduction. Stress-induced gene expression. Gene traps and enhancer traps.

PBG 513 Maintenance Breeding and Concepts of Variety Release and Seed Production **1+1** **Sem. I**

Variety development and maintenance. Defining variety, cultivar, extant variety, derived variety, reference variety, farmers' variety, hybrid and population. Variety testing, release and notification systems in India and abroad. US testing. Genetic deterioration of varieties. Maintenance of varieties. Principles of seed production. Generation system of seed multiplication. Quality seed production of cereals and millets, pulses, oilseeds, cotton and forages. Seed certification. Seed laws and plant variety protection regulations in India and international systems.

Practical: Identification of suitable areas for seed production. Ear-to-row method and nucleus seed production. Main characteristics of released and notified varieties, hybrids and parental lines. Identification of important weeds/objectionable weeds. Determination of isolation distance and planting ratios in different crops. Seed production techniques of varieties in different crops. Hybrid seed production technology of important crops.

PBG 514 Collection, Management and Utilization of Plant Genetic Resources **3+1** **Sem. II**

Germplasm exploration, collection and preservation. Ecological zones and genetic diversity. Post-exploration handling. Present status and future strategies in collection of crops such as rice, maize, sorghum, sesame, Brassica, cotton, etc. National and international legislations on germplasm collection and exchange. Database management system, statistical softwares, pictorial and graphical representation of data. Introduction of binomial, normal and negative cumulative normal. Use of probit scales, viability equations and nomograms. Germplasm documentation. Germplasm management system, global scenario. Management and utilization of germplasm collection. Predictive methods for identification of germplasm. Pest risk analysis, pest and pathogen information database. Quarantine in relation to integrated pest management. Detection and identification of pests including use of recent techniques like ELISA, PCR etc. International linkages in plant quarantine. GMOs or GEPs: concepts of biosafety and risk analysis, treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs and Indian regulatory system for biosafety. Concept of core collection. Pre-breeding. Harmonizing agrobiodiversity and agricultural development. Crop diversification. Participatory plant breeding.

Practical: Plant exploration and collection. Introductions. Techniques of coarse and fine grid surveys. Identification of wild relatives of crop plants. Estimation of sample size during plant explorations, impact of sampling, sequential sampling. Sample size for storage and viability testing. Test cases to understand quarantine regulations. Techniques for the detection of insects, mites, nematodes, bacteria, weeds, pathogens and viruses on seed and planting materials and salvaging. Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques (controlled green houses/growth chambers, etc). Detection of GMOs and GEPs. Study of post-entry quarantine operation, seed treatment and other prophylactic treatments and preparation of herbarium specimens. Analysis of genetic diversity. Information management

PGS 502 Intellectual Property Management, Biodiversity and Biosafety 2+0 Sem. I & II

Introduction to Intellectual Property: history, concepts and types. International treaties and conventions for protection of IP'S. Role of intellectual property in growth, development, trade and commerce; Indian legislations for the protection of various types of Intellectual Property with a special reference to history and evolution of the concepts of geographical indicators, variety protection and patents. R & D expenditure vis-à-vis patents. PPVFRA: Process for protection of plant varieties, issues related to compliance and infringements. GI: Process for protection of goods, community involvement and benefit sharing. Patents: Search, process of filing patents, infringement and compliances. Biodiversity: Definition, importance, historical and geographical causes for diversity. Species and population biodiversity, Maintenance of ecological biodiversity. Biodiversity hot spots in India, Collection, conservation, documentation and characterization of biodiversity, development and maintenance of live repositories, community gene banks. Convention on biological diversity. National biodiversity protection initiatives; sustainable use of bio-diversity, benefit sharing, Bio-safety guidelines for the development and protection of genetically modified organisms; Cartagena Protocol of Bio-safety, its objective, salient features, risk assessment and risk management for GMO's, Bio-safety guidelines, rules and regulations and regulatory frame work for GMO in India; institutional arrangements at national level, procedure for direct use of GMO's in India. Licensing of technologies, Material transfer agreements, Research collaboration agreement, License Agreement.

PBG 601 Genomics in Plant Breeding 2+1 Sem. II

Introduction to the plant genome. Chloroplast and mitochondrial genomes. Genome size and complexity. Establishment of plant genome mapping projects. Genome mapping and use of molecular markers in plant breeding. Approaches for mapping quantitative trait loci. Map based cloning of plant genes. Regulation of plant gene expression. Functional genomics. Expression Analysis using Microarrays. Transposon tagging and insertional mutagenesis. Diversity array technology. Principles, techniques and applications of genome sequencing in plants. Comparative genomics: techniques and approaches. Detection of single nucleotide polymorphism. TILLING and Eco-TILLING. Role of transcriptomics, proteomics and metabolomics in linking genome and phenome. Knock out mutant studies and high throughput phenotyping. Concept of database development, management and bioinformatics.

Practical: Chromosome analysis. FISH. Comparative genomic hybridization. Comparative analysis of genomes using molecular markers. Genetic map construction. Mapping major genes. QTL mapping in plants. Plant genome databases. Computational tools to explore plant genome databases. Comparative genomics. Comparison of genome sequences using tools of bioinformatics. TILLING and Eco-TILLING. DNA array technology. Tools of transcriptomics, proteomics and metabolomics.

PBG 602 Molecular and Chromosomal Manipulations for Crop Breeding 2+0 Sem. II

Organization and structure of genome. Transcriptional and translational changes. Inheritance and expression of organellar DNA. Karyotyping. Tracking introgressions using FISH and GISH. Distant hybridization. Role of polyploids in crop evolution and breeding. Applications of cytogenetical methods for crop improvement. Totipotency of cells. Molecular Breeding: constructing molecular maps, integrating genetic, physical and molecular maps. diversity assessment and phylogenetic analysis. Gene tagging. Marker assisted selection of qualitative and quantitative traits. Genome structure and organization: cytogenetic and molecular analysis. Recent techniques of chromosome engineering. Crop genome evolution: progenitors and related species, comparative mapping, synteny. Gene expression in polyploids and wide hybrids. Alien gene introgression in crop improvement. Recent advances, analysis and manipulation of crop genomes in wheat, rice, pearl millet, maize, cotton, oilseed, Brassicas, sunflower, soybean, pigeon pea, Vigna species and sugarcane. Current research topics in cytogenetics.

PBG 603 Advances In Plant Breeding Systems 2+0 Sem. I

Evolutionary concepts. Flower development, whorls formation and proposed models. Mating systems. Pollination mechanisms. Populations, gene pool, composites and synthetics. Complex population. Population improvement. Selection in self fertilizing crops. Genetic variability. Mass selection, pureline selection, pedigree method. Backcross, polycross and test cross. Selection in cross fertilizing crops. Polycross, topcross, mass and recurrent selection. Convergent and divergent selection. Recurrent selection, GCA and SCA. Selection in clonally propagated crops. Self-incompatibility and sterility. Male sterility and genetic engineering to create male sterility. Case studies: fertility restoration, conversion of

agronomically ideal genotypes into male steriles, new cytonuclear interaction system for diversification of male steriles, photo and thermo sensitive genetic male sterility. Apomixis and its use in heterosis breeding. Incongruity.

PBG 604 Breeding Designer Crops **2+1** **Sem. II**

Breeding of crop ideotypes. Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement: proteins, vaccines, gums, starch and fats. Physiological efficiency, parametric and whole plant physiology for improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement. Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships. Enhancing input use efficiency through genetic manipulations. Breeding for special traits viz., oil, protein, vitamins, amino acids etc. Biopharming and development of varieties producing vaccines, modified sugars, gums and starch. 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.

PBG 605 Plant Genetic Resources and Crop Evolution **2+0** **Sem. I**

Historical perspective and need for PGR conservation. Domestication. Gene pools. Basic genetic resources and transgenes. Exploration and collection of PGR-national and international protocols. Plant quarantine and phytosanitary certification. Germplasm exchange. Cryopreservation. Germplasm conservation. Orthodox seeds and vegetatively propagated crops. Registration of plant genetic resources. PGR database management. Multivariate and clustering analysis, descriptors. PGR for food and agriculture (PGRFA). PGR access and benefit sharing. Role of CGIAR system in the germplasm exchange. Geographical indicators. Genetics enhancement. Distant hybridization and introgression. Pre breeding. Utilization of genetic resources, concept of core and minicore collections. Origin and evolution of crop species. Patterns of evolution. Selection and genetic drift. Speciation and extinction. Stabilization of polyploids. Multifactorial design. Intragenomic and intergenomic interactions. Protein and DNA based methods to study crop evolution. Genome analysis and comparative genomics.

PBG 606 Advanced Biometrical and Quantitative Genetics **2+1** **Sem. I**

Principles of Biometrical genetics. Selection of parents. Advanced biometrical models for combining ability analysis. Simultaneous selection models. Multiple regression analysis. Designs and systems. Models in stability analysis. Pattern analysis. Additive Main Effect and Multiplicative Interaction (AMMI) analysis. Principal component analysis. Additive and multiplicative model. Biplots and mapping genotypes. Genetic architecture of quantitative traits. Conventional analyses to detect gene actions. Partitioning of phenotypic/genotypic variance. Construction of saturated linkage maps. QTL mapping. Marker assisted selection (MAS). Practical : Working out efficiency of selection methods in different populations and interpretation. Biparental mating. Triple Test Cross (TTC). Advanced biometrical models for combining ability analysis. Stability analysis. Additive Main Effect and Multiplicative Interaction (AMMI) model. Principal Component Analysis model. Biplots and mapping genotypes. Construction of linkage maps and QTL mapping and statistical methods in QTL mapping. Phenotype and marker linkage studies.

PBG 607 Advances in Breeding of Major Field Crops **3+0** **Sem. I**

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals and millets like rice, wheat, maize, pearl millet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Breeding objectives of major crops. Genetic resources and their utilization. Genetics of quantitative and qualitative traits. Breeding for value addition and resistance to abiotic and biotic stresses. Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of

new male sterility systems and transgenics). National and International accomplishments in genetic improvement of major field crops and their seed production.

PBG 608 Microbial Genetics

2+1

Sem. I

Nature of bacterial variation. Molecular aspects of mutation. Episomes and plasmids. Gene mapping in bacteria. Life cycle of bacteriophages. Genetic fine analysis of rII locus. Circular genetic map of phage T4. Transposable elements. Gene manipulation. Biochemical genetics of *Neurospora* and *Sacharomyces*. One gene - one enzyme hypothesis. Regulation of gene activity in prokaryotes. Molecular mechanisms of mutation, repair and suppression. Molecular chaperones and gene expression. Genetic basis of apoptosis. Transgenic bacteria and bioethics. Genetic basis of nodulation, nitrogen fixation and competition by rhizobia, genetic regulation of nitrogen fixation and quorum sensing in rhizobia. Genetics of mitochondria and chloroplasts.

Practical: Preparation of bacterial nutrient media. Assessment of generation time in the log-phase bacterial cultures. Handling of microorganisms. Isolation of rhizobia. Gram staining. Examination of polyhydroxy butyrate (PHB) production in rhizobia. Demonstration of N₂-fixing nodules/bacterial inoculation in the legume-Rhizobium symbiotic system. Induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria. Determination of spontaneous and induced mutation frequencies. Discrete bacterial colony counts for the preparation of survival curves and determination of LD₅₀ of a mutagen. Tn-mediated mutagenesis. Analysis and isolation of plasmid DNA. Curing of plasmids.

PBG 609 *In Situ* and *Ex Situ* Conservation of Germplasm

2+1

Sem. II

Natural reserves and gene banks. In situ conservation of wild species. In situ conservation components, factors influencing conservation value, national plan for in situ conservation. In situ conservation of agrobiodiversity on-farm. 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 sending seeds to network of active/ working collections, orthodox, recalcitrant seeds, clonal repositories, genetic stability under long term storage condition. In vitro storage. Cryopreservation. Cryoprotectants, desiccation, rapid and slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agriculture. Problems and prospects. Challenges ahead.

Practical: In situ conservation of wild species - case studies at National and International levels- ex situ techniques for active and long-term conservation of collections- Preparation and handling of materials, packaging, documentation. Design of cold storage modules- Conservation protocols for recalcitrant and orthodox seeds. Cytological studies for assessing genetic stability, in vitro cultures-embryo, cell/suspension cultures, pollen cultures, study of cryotank facility and vitrification techniques. Visit to NBPGR/NBAGR.

PBG 591 Seminar

PBG 600 Master's Research

PBG 700 Ph. D. Research

PLANT PATHOLOGY

A. PLANT PATHOLOGY PROGRAMME

1. M.Sc.

2. Ph.D

COURSE REQUIREMENTS

M. Sc.

Field of Specialization	Fungal Pathology, Plant Bacteriology, Plant Virology
Required Courses	Pl.Path.501, Pl. Path. 502, Pl.Path.503, Pl.Path.504, Pl.Path.505
Supporting Courses	Stat.421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem.
Minor Fields	Agrometeorology, Biochemistry, Entomology, Fruit Science, Nematology, Plant Breeding and Genetics, Biotechnology, Vegetable Science, or any other as approved by the Dean, Postgraduate Studies.
Deficiency courses for students with elective other than Crop Protection	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D

Field of Specialization	Fungal Pathology, Plant Bacteriology, Plant Virology
Required Courses	Pl. Path. 601, Pl. Path. 602, Pl.Path.603, Pl.Path. 604, Pl. Path. 605
Supporting Courses	Courses from subject matter fields (other than minor) relating to area of special interest and research problem.
Minor Fields	Agrometeorology, Biochemistry, Entomology, Fruit Science, Nematology, Plant Breeding and Genetics, Biotechnology, Vegetable Science, or any other as approved by the Dean, Postgraduate Studies.
Deficiency courses for students with M. Sc. (Agri.) in a discipline other than Plant Pathology	Pl.Path.501, Pl.Path.502, Pl.Path.503, Pl.Path.504, Pl. Path. 505, and other courses as recommended by Student's Advisory Committee.

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Pl. Path. 101 Plant Pathogens and Principles of Plant Pathology	2+1	Sem. II
Introduction, importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites . Definition, objectives, history, terms and concept of plant pathology. Survival and dispersal of plant pathogens. Phenomenon of infection. Study of genera Pythium, Phytophthora, Albugo, Sclerospora, Peronosclerospora, Pseudoperonospora, Peronospora, Plasmopara, Bremia, Mucor, Rhizopus, Oidium, Erysiphe, Phyllactinia, Uncinula, Podosphaera, Puccinia, Uromyces, Hemileia, Sphacelotheca, Ustilago, Tolyposporium, Agaricus, Pleurotus, Ganoderma, Septoria, Colletotrichum, Pestalotia, Pyricularia, Aspergillus, Penicillium, Trichoderma, Fusarium, Drechslera, Alternaria, Stemphyllium, Cercospora, Phaeoisariopsis, Rhizoctonia, Sclerotinia, Xanthomonas, Pseudomonas, Meloidogyne and Anguina. Defence mechanisms in plants.		

Plant disease epidemiology and forecasting. General principles of plant disease management. Plant quarantine and inspection. Genetic, cultural, biological, physical and chemical methods of plant disease management. Integrated plant disease management.

Practical: Acquaintance to plant pathology laboratory equipments. Preparation of culture media for fungi and bacteria. Isolation techniques and preservation of plant disease samples. Study of important plant pathogenic genera. Demonstration of Koch's postulates. Study of different groups of fungicides and antibiotics. Bio-control of plant pathogens. Visit to remote sensing laboratory and experimental area.

PI. Path. 201 Diseases of Field Crops and their Management **2+1** **Sem. I**

Economic importance, symptoms, causal organism, epidemiology, disease cycle and integrated management of diseases of rice, sorghum, bajra, maize, wheat, barley, sugarcane, turmeric, tobacco, groundnut, sesamum, castor, sunflower, rapeseed & mustard, cotton, pulses, mentha and berseem.

Practical: Study of symptoms and host-parasite relationships of important diseases of field crops. Field visits at appropriate time during the semester.

PI. Path. 303 Diseases of Horticultural Crops and their Management **2+1** **Sem. II**

Economic importance, symptoms, causal organism, epidemiology, disease cycle and integrated management of diseases of citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, ber, apple, pear, peach, plum, chilli, brinjal, okra, potato, crucifers, cucurbits, tomato, pea, beans, onion, garlic, coriander, coconut, betelvine, mulberry, coffee, tea, rose, chrysanthemum, gladiolus, marigold and jasmine.

Practical: Study of symptoms and host-parasite relationships of important diseases of horticultural crops. Field visits at appropriate time during the semester.

Undergraduate Elective/M. Sc. Supporting/ Minor Courses

PI. Path. 433 Plant Disease Diagnosis **0+2** **Sem. I**

Field diagnosis of important diseases of Rabi and Kharif crops, vegetables, fruits, forest and ornamental plants. Estimation of losses and methods for assessing the intensity of diseases like angular leaf spot of cotton, Tikka disease of groundnut, yellow mosaic of beans, downy mildew of bajra, rusts and loose smut of wheat, Alternaria blight, downy mildew of mustard and powdery mildew of pea. Methods of soil sterilization for raising healthy nursery plants. Solar-heat treatment. Methods of producing virus-free citrus and potato. Diagnosis and differentiation of disorders due to viruses, nutritional imbalances, genetic variations and toxaeimias. Types of chemicals used for the control of plant diseases and methods of their application. Cultural and biological methods of plant disease control.

PI. Path. 434 Biocontrol and Integrated Disease Management **2+2** **Sem. I**

History and principles underlying host resistance, chemical, physical, cultural, biological and legislative measures of plant disease management. Scope and factors affecting biological control. Mechanisms of bio-control. Characterization of bioagents and their commercial formulations. Limitations of bio-control. Commercial production and distribution system. Integrated disease management. Historical developments and classification of fungicides and antibiotics. Mode of action, uptake, translocation, disease control and factors affecting their efficacy and field performance. Registration, commercial development and compatibility of fungicides with other chemicals. General account of plant protection appliances. Development of resistance in pathogens against fungicides. Non-target effects of fungicide use. Methods of screening for disease resistance. Seed certification standards and phytosanitary measures. Practical: Isolation and Identification of bio-control agents. Evaluation of bio-control agents against plant pathogens in vitro and in vivo. Production and application procedures. Laboratory evaluation of fungicides and antibiotics by various methods against different groups of pathogens. Methods of application of fungitoxicants. Absorption, translocation and persistence of different fungitoxicants. Integration of bio-control agents with other methods of plant disease control.

PI. Path. 435 Post Harvest Diseases and their Management **2+1** **Sem. I**

Importance of post-harvest diseases. Important post-harvest diseases of fruits and vegetables. Factors affecting ripening of fruits and vegetables. Factors favoring development of post-harvest diseases. Effect of

handling and storage practices on the development of post-harvest diseases. Storage methods and conditions. Disease management strategies for post-harvest diseases. Practical: Important post-harvest diseases of fruits and vegetables like mango, citrus, guava, grapes, pear, cucurbits, chilli, tomato and potato. Study of factors favouring development of post-harvest diseases. Disease development under different storage conditions. Demonstration of various methods of disease management. Visit to a packing house.

Postgraduate Courses

PI. Path. 501 Mycology 2+1 Sem. I

Introduction, basic concepts and terminology. Mycology in relation to agriculture and mankind. History of mycology. Concepts of nomenclature and classification. Fungal biodiversity. Reproduction in fungi. Comparative morphology, ultrastructure and characters of different groups of fungi up to generic level of Divisions Myxomycota and Eumycota emphasizing sub-divisions Mastigomycotina Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Types of Lichens and importance, fungal genetics and variability in fungi. Practical: Comparative study of different groups of fungi up to generic level of Divisions Myxomycota and Eumycota emphasizing sub-divisions Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Collection, identification and preservation of specimens. Isolation and identification of plant pathogenic fungi.

PI. Path. 502 Plant Virology 2+1 Sem. II

History of plant viruses, their composition and structure. Symptomatology of important plant viral diseases, transmission, chemical and physical properties. Host virus interaction and virus vector relationship. Virus nomenclature and classification, genome organization, replication and movement. Isolation, purification, electron microscopy, protein and nucleic acid based diagnostics. Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, and prions. Origin and evolution, mechanism of resistance and genetic engineering of plant viruses. Study of representative viral/mycoplasmal diseases, emphasizing their distribution, symptomatology, etiology, epidemiology and principles of plant viral disease control.

Practical: Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, isolation and purification, method of raising antisera, serological tests, electron microscopy and ultratomy, molecular diagnostics. Diagnosis of representative viral diseases.

PI. Path. 503 Plant Bacteriology 2+1 Sem. II

History of bacteriology and introduction to phytopathogenic procarya. Importance of phytopathogenic bacteria. Evolution, classification and nomenclature of phytopathogenic procarya. Survival and dissemination of phytopathogenic bacteria. Important diseases caused by procarya. Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya. General biology of bacteriophages, L- form bacteria, plasmids and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria.

Practical: Isolation, purification, identification and host inoculation of phytopathogenic bacteria. Staining methods, biochemical and serological characterization. Isolation of plasmid and use of antibacterial chemicals/antibiotics.

PI. Path. 504 Principles of Plant Pathology 3+0 Sem. I

Importance, terminology and concepts of plant diseases. History and growth of plant pathology. Biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens. Role of environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection. Symptomatology, disease development. Role of enzymes, toxins, growth regulators. Defense strategies, oxidative burst, phenolics, phytoalexins, PR proteins and elicitors. Altered plant metabolism as affected by plant pathogens. Genetics of resistance, 'R' genes, mechanism of genetic variation in pathogens, molecular basis for resistance, marker-assisted selection and genetic engineering for disease resistance. Disease management strategies.

- PI. Path. 505 Principles of Plant Disease Management** **2+1** **Sem. I**
 Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals. Integrated control measures of plant diseases. Disease resistance and molecular approach for disease management. Foliage, seed and soil application of chemicals. Role of stickers, spreaders and other adjuvants. History of fungicides, bactericides, antibiotics, antivirals. Concepts of pathogen, immobilization, chemical protection and chemotherapy. Nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals. Recent trends in the development of fungitoxicants, antibiotics and antiviral agents and relationships between their structures and activity. Environmental hazards, residual effects and safety measures.
 Practical: In vitro and in vivo evaluation of chemicals against plant pathogens. Foliage, seed and soil application of chemicals. Role of stickers, spreaders and other adjuvants. ED and MIC values. Study of structural details of sprayers and dusters. Environmental hazards, residual effects and safety measures.
- PI. Path. 506 Detection and Diagnosis of Plant Diseases** **0+2** **Sem. II**
 Isolation of pathogens using selective media, pure culture techniques. Methods to prove Koch's postulates with biotroph and necrotroph pathogens. Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, chromatography, phase contrast and electron microscopy, spectrophotometer, ultracentrifuge and electrophoretic apparatus. Serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides and bactericides. Data collection and preparation of reports.
- PI. Path. 507 Integrated Disease Management** **2+1** **Sem. I**
 Introduction, definition, concept and tools of disease management. Components of integrated disease management, their limitations and implications. Development of IDM and its adaptation in important crops, rice, wheat, cotton, sugarcane, chickpea, rapeseed mustard, pearl millet, Kharif pulses, vegetable and fruit crops.
 Practical: Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM. Demonstration of IDM in certain crops as project work.
- PI. Path. 508 Epidemiology and Forecasting of Plant Diseases** **2+0** **Sem. II**
 Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis. Common and natural logarithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens. Survey, surveillance and vigilance, crop loss assessment and models. Principles and pre-requisites of forecasting, systems and factors affecting various components of forecastings, some early forecasting, procedures based on weather and inoculum potential, modelling disease growth and disease prediction.
- PI.Path. 509/Ent.509/Nem. 509 Molecular Approaches in Plant Protection** **2+1** **Sem. II**
 Recent concepts of molecular biology and techniques used in plant protection. Genes of interest in plant protection. Identification, characterization and isolation of novel genes involved in pest resistance. Molecular basis of host plant-insect and pathogen interactions. PR-proteins and G- proteins. Molecular characterization of biodiversity-insects and pathogens. Molecular biology of baculoviruses. Molecular mechanisms of genetically engineered plants for pest resistance and pesticide resistance. Improvement of biocontrol agents and useful insects using molecular techniques. Bio-safety related issues.
 Practical: Molecular characterization of pest populations. Detection of biotypes/races. Establishment of phylogenetic relationships/dendrograms. Detection of Cry-gene and estimation of cry-toxin; characterization of capsid proteins of insect viruses. Detection of disease induced biochemical changes at molecular level.
- PI.Path.510/ Ent.510/ Nem. 510 Quarantine in Plant Protection** **2+0** **Sem. II**
 Definition of pest and pesticides and transgenics as per Govt. notification. Relative importance and quarantine for domestic and international. Quarantine restrictions in the movement of agricultural produce including seeds and planting material. Case histories of exotic pests and diseases and their status. Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine

legislations. PQ Order 2003. Environmental Acts and APEDA. Industrial registration. Import and Export of bio-control agents. Special requirements for biopesticide registration. Identification of pest and disease free areas. Contamination of food with toxigens of micro-organisms and their elimination. Symptomatic diagnosis and other techniques to detect pest/pathogen infestations. VHT and other safer techniques of disinfection and salvaging of infected material. WTO regulations. Non-tariff barriers. Pest risk analysis and good laboratory practices for pesticide laboratories. Pesticide industry. Sanitary and phytosanitary measures.

Pl. Path. 511 Post Harvest Diseases **2+1** **Sem. II**

Concept of post harvest diseases, definitions, importance with reference to environment and health. Post-harvest diseases of fruits and vegetables. Factors governing post-harvest problems. Role of physical environment, agro-ecosystem leading to quiescent infection. Concept of microbial associations, rhizosphere/ rhizoplane colonization, competitive saprophytic ability, antibiosis, induced resistance. Operational mechanisms and cultural practices in perpetuation of pathogens. Operational mechanisms, handling and its relevance in control. Management of aflatoxigenic and mycotoxigenic fungi. Antagonists, their relationship and role as biocontrol agents. Chemicals in controlling post-harvest diseases. Merits and demerits of phyto-extracts in controlling post-harvest diseases. Integrated approach in controlling diseases and improving the shelf life of produce. Codex Alimentarius for agro-product and commodity.

Practical: Isolation, characterization and maintenance of important post-harvest pathogens. Role of different storage conditions for disease development. Application of antagonists against pathogens under in vitro and in vivo conditions. Comparative efficacy of different chemicals, fungicides, phyto-extracts and bioagents.

Pl. Path. 512 Fungal Diseases of Plants **2+1** **Sem. I**

Nomenclature, classification and general characterization of fungi. Description of important phytopathogenic genera. Study of representative fungal diseases with emphasis on their distribution, symptomatology, etiology, epidemiology and control. Post harvest diseases in transit and storage and their management.

Practical: Characteristics of important phytopathogenic genera and of fungi and their identification. Macro and microscopic diagnosis of representative diseases of various crops.

Pl. Path. 601 Ecology of Plant Pathogens **2+0** **Sem. II**

Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi. Dispersal, survival and dormancy of plant pathogens. Types of biocontrol agents. Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis. Role of rhizosphere, phyllosphere and spermosphere in disease development in relation to crop sequences. Suppressible soils, biological control, concepts and potentialities for managing soil borne pathogens.

Pl. Path. 602 Molecular Basis of Host-Pathogen Interaction **2+0** **Sem. II**

Importance and role of biotechnological tools in Plant Pathology. Basic concepts and principles to study host pathogen relationship. Molecular basis of host-pathogen interaction, fungi, bacteria and viruses. Recognition system and signal transduction. Induction of defense responses, pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance. Programmed Cell death. Viral induced gene silencing. Molecular basis of gene-for-gene hypothesis. R-gene expression, transcription profiling, mapping and cloning of resistance genes, marker-aided selection and pyramiding of R genes. Biotechnology and disease management, development of disease resistant plants using genetic engineering approaches. Different methods of gene transfer.

Pl. Path. 603 Principles and Procedures of Certification **2+0** **Sem. II**

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 vegetative propagules and in vitro

cultures and genetic identity, physical purity, germination percentage, seed health etc. Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

PI. Path. 604 Advanced Systematic Mycology **3+0** **Sem.I**

General introduction, historical development and advances in mycology. Recent taxonomic and morphological criteria for classification. Serological, chemical, molecular and numerical taxonomy. Interaction between groups and their Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti. Morphology and reproduction of representative plant pathogenic genera. Sexual reproduction in different groups of fungi. Population biology. Pathogenic variability. Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra- nuclear inheritance. Biodegradation.

PI. Path. 605 Advanced Plant Virology **2+0** **Sem. II**

Virus Replication, assembly and architecture of plant viruses. Ultrastructural changes due to virus infection. Variation, mutation and virus strains. Mechanism of virus transmission by vectors, virus-vector relationship. Bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses. Molecular mechanism of vector transmission, symptom expression, viroids and prions. Immunoglobulin structure and functions of various domains. Methods of immunodiagnosis, hybridoma technology, use of monoclonal antibodies. Polymerase Chain Reaction in identification of viruses and their strains. Genome organization, replication, transcription and translational strategies of pararetroviruses and geminiviruses. Satellite viruses and satellite RNA genome organization in tobamo, poty, bromo, cucummo, ilar and tospoviruses. Gene expression and regulation, viral promoters. Molecular mechanism of host virus interactions. Virus induced gene.. Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses as potential vectors. Genetically engineered resistant and transgenic plants. Techniques and application of tissue culture. Origin, evolution and interrelationship with animal viruses.

PI. Path. 606 Advanced Plant Bacteriology **2+0** **Sem.I**

Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and biology of bacteria. Role of enzyme, toxin, exopolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of crown gall formation (*Agrobacterium tumefaciens*). Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein. Molecular variability among phytopathogenic procarya and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pathogens, gene silencing and RNAi technology. Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit. Beneficial prokaryotes. Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

PI. Path. 591 Seminar

PI. Path. 600 Master's Research

PI. Path. 700 Ph. D. Research

B. NEMATOLOGY PROGRAMME

M.Sc.

COURSE REQUIREMENTS

Field of Specialization	Nematode Taxonomy, Host -parasite Relationships, Nematode Management, Nematode Ecology, Nematode Biology
Required Courses	Nem. 501 , Nem. 502, Nem. 503 , Nem. 504, Nem. 505.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem
Minor Fields	Entomology, Fruit Science, Microbiology, Plant Pathology and Vegetable Science or any other as approved by the Dean, Postgraduate Studies
Deficiency courses for students with elective other than Crop Protection	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Undergraduate Elective/M. Sc. Supporting/ Minor Courses

Nem. 433 Plant Nematology	1+1	Sem. I
History and economic importance of plant parasitic nematodes. General characteristics, identification, their classification and relationship with other organisms. Morphology and biology of important genera, namely Meloidogyne, Heterodera, Globodera, Anguina, Rotylenchulus, Ditylenchus, Tylenchulus, Pratylenchus, Radopholus and virus vectors. Principles and methods of control. Practical: Methods of survey, collection of soil and plant samples. Extraction of nematodes and population estimation. Preparation of temporary and permanent mounts. Study of morphological characteristics and disease symptoms. Application of nematicides.		

Postgraduate Courses

Nem. 501 Structural and Functional Organization of Nematodes	2+1	Sem.1
General organization of nematode body. Morphology and anatomy of nematode cuticle, hypodermis, musculature and pseudocoelom. Structural variations of stoma, esophagus, intestine and rectum in nematodes. Reproductive system, its variations, terminology, nemic eggs and sperms and types of reproduction, spermatogenesis and oogenesis. Types and structure of excretory systems. Nervous system and associated sense organs. Practical: Studies on variation in nematode shapes and sizes, morphological details of cuticle, cuticular markings and ornamentation, variations in stoma, esophagus, rectum; types and parts of female and male reproductive systems, sense organs, and excretory system.		
Nem. 502 Classification of Nematodes	2+1	Sem.I
Nematode systematics and comparison with its allies. Comparative study of morphological and allometric variations and evaluation of characters of classification. Classification of Phylum Nematoda. Orders of class Adenophorea and Secernentea. Diagnosis of order Tylenchida- Suborder Tylenchina, Hoplolaimina and Criconeimatina, their families and genera. Diagnosis of genera and families of orders Aphelenchida, Dorylaimida, Enoplida, Rhabditida with emphasis on economically important taxa. Practical: Identification of common plant parasitic nematodes belonging to orders Tylenchida, Dorylaimida, Aphelenchida and Enoplida up to generic level and up to species level for major nematode pests of crops with the help of keys and illustrations. Identification of Entomopathogenic nematodes belonging to Order Rhabditida.		

Nem. 503 Nematological Techniques **1+2** **Sem.I**

Methods of survey and surveillance. Soil and plant sampling for characterizing nematode communities. Techniques for extraction of nematodes from soil and plant material. Sterilization of soil and culture media. Killing, fixing, clearing and mounting nematodes; Nematode measurements, in vitro and in vivo culturing techniques of plant parasitic, bacteriophagous, mycophagous and omnivorous nematodes. Staining nematodes in plant tissues. Microtomy for histopathological studies. Collection of plant root exudates and their bioassay. Principles and use of light, scanning and transmission electron microscopes, and other laboratory equipments. Application of molecular techniques in Nematology.

Practical: Collection of soil and plant samples. Extraction of nematodes from soil and plant material. Estimation of population densities. Staining plant material for nematodes. Mounting nematodes by slow and Seinhorst's methods; preparation of temporary and permanent mounts. Preparation of perineal pattern, vulval cone, en-face views and body section of nematodes. Measurements, drawing, microphotography. Collection of root exudates, preparation of exhibits of nematode diseased plant material, in vitro culturing techniques of nematodes- callous culture, excised root and carrot disc techniques.

Nem. 504 Nematode Diseases of Crops **2+1** **Sem.II**

Diagnosis of Nematode diseases, their causal organisms, distribution, host range, biology, life cycle, nature of damage, symptoms and management in different crops. Nematode parasites as primary or secondary pathogens. Disease concept terminology. Interaction of nematodes with other organisms. Detailed account of ear-cockle, tundu and molya diseases of wheat. Cyst, rice root nematode, ufra and white tip diseases of rice. Lesion and cyst nematodes of maize and sorghum. Root knot, reniform, lesion, lance nematode, sugarbeet cyst, pigeon pea cyst and soybean cyst nematode problems on pulses, sugar cane, fibre, fodder and oilseed crops. Root-knot, reniform, stem and bulb nematode, potato cyst nematode on vegetable crops. Nematode problems of protected cultivation. Root-knot and reniform nematode on fruit crops. Slow decline of citrus. Mushroom nematode problems. Burrowing nematode problem of banana, spices and condiments, Root-knot and lesion nematode diseases of coffee and tea. Red ring disease of coconut and pine wilt disease.

Practical: Diagnosis of causal organisms. Identification of different life cycle stages. Study of symptoms and histopathology of nematode damage in different crops and field diagnosis of nematode problems.

Nem. 505 Nematode Management **2+1** **Sem.II**

Concepts and history of nematode management. Crop loss estimation. Nematicides, their types, classification, mode of action, applicators, application methods, and antidotes. Cultural practices including sanitation, crop rotations and cropping sequences, fallowing, flooding, soil solarisation, time of sowing, organic amendments of soil, biofumigation and trap crops. Use of heat, hot water treatment and other methods of disinfestations of planting material. Biocontrol methods, concept and terminology, use of predators and parasites as biological control agents, their mass multiplication and field use. Antagonistic plants and antinematic plant products. Plant resistance. Host defence system, morphological and anatomical resistance. Chemicals in host defence, post infectious chemicals, phytoalexins, hypersensitivity and its mechanisms. Quarantine regulations and pest risk analysis; integrated nematode management-concepts and applications. Pest risk analysis. Pesticide risks, cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

Practical: In vitro screening of synthetic chemicals and plant products for nematicidal activity, and their application methods. Methods for screening of crop germplasm for resistance against nematodes. Laboratory exercises on biocontrol potential of fungal, bacterial parasites, predaceous fungi and nematodes.

Nem. 506 Principles of Taxonomy **2+0** **Sem.I**

History and principles of systematics and its importance. Levels and functions of systematics. Identification methods, character matrix and taxonomic keys. Taxonomic characters. Analogy vs homology, parallel vs convergent evolution, intraspecific variation in characters. Polythetic and polymorphic taxa. Sexual dimorphism. Phenetics, cladistics and evolutionary classification. Components of biological classification: hierarchy, rank, category and taxon. Species concepts, cryptic, sibling and etho-species, infra-specific categories. Speciation, anagenesis vs cladogenesis, allopatric, sympatric and parapatric processes.

Introduction to numerical, biological and cytogenetical taxonomy. Common vs Scientific names. International Code of Zoological Nomenclature(ICZN), criteria for availability and validity of names. Categories of names under consideration of ICZN. Principles of priority, and homonymy, synonymy, type concept in zoological nomenclature.

Nem. 507 Nematode Biology and Physiology **1+1** **Sem.I**

Host finding, invasion, feeding, hatching, moulting and life cycle patterns in different types of nematodes. Types of reproduction, gametogenesis, embryogenesis and post embryogenesis in nematodes. Physiology of body wall and chemical composition of nematodes. Hydrolytic enzymes, pseudocoelom and function of transport in nematodes. Physiology of digestive system. Respiration and intermediary metabolism. Osmoregulation. Physiology of nutrition, excretory-secretory and neuromuscular systems in nematodes.

Practical: Studies on embryogenesis and post-embryogenesis, hatching, moulting, life cycle development, feeding, enzymatic assay by electrophoresis.

Nem. 508 Nematode Ecology **1+1** **Sem.II**

Definition and scope. Components of environment. Evolution of nematodes. Ecological classification. Prevalence, distribution and dispersal of nematodes. Role of nematodes in the food web. Community analysis and population estimation models. Effects of abiotic and biotic factors on nematodes. Environmental extremes and nematode behaviour. Survival strategies of nematodes in adverse environment. Modelling population dynamics and relations with crop performance; ecological considerations in nematode management, data interpretation and systems simulation.

Practical: Study of nematode fauna in varied agro-ecological systems, community analysis of nematode populations, laboratory exercises on influence of abiotic factors on movement and hatching, green-house experiments on effect of abiotic factors on nematode populations and plant growth. Pathogenicity of nematodes alone or in association with other organisms.

Nem. 509/Ent.509/PI.Path.509 Molecular Approaches in Plant Protection **2+1** **Sem.II**

Recent concepts of molecular biology and techniques used in plant protection. Genes of interest in plant protection. Identification, characterization and isolation of novel genes involved in pest resistance. Molecular basis of host plant-insect and pathogen interactions. PR-proteins and G- proteins. Molecular characterization of biodiversity-insects and pathogens. Molecular biology of baculoviruses. Molecular mechanisms of genetically engineered plants for pest resistance and pesticide resistance. Improvement of biocontrol agents and useful insects using molecular techniques. Bio-safety related issues.

Practical: Molecular characterization of pest populations. Detection of biotypes/races. Establishment of phylogenetic relationships/dendrograms. Detection of cry-gene and estimation of cry-toxin; characterization of capsid proteins of insect viruses. Detection of disease induced biochemical changes at molecular level.

Nem. 510/Ent.510/PI.Path.510 Quarantine in Plant Protection **2+0** **Sem.II**

Definition of pest and pesticides and transgenics as per Government notification. Relative importance and quarantine for domestic and international. Quarantine restrictions in the movement of agricultural produce including seeds and planting material. Case histories of exotic pests and diseases and their status. Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations. PQ Order 2003. Environmental Acts and APEDA. Industrial registration. Import and Export of bio-control agents. Special requirements for biopesticide registration. Identification of pest and disease free areas. Contamination of food with toxigens of micro-organisms and their elimination. Symptomatic diagnosis and other techniques to detect pest/pathogen infestations. VHT and other safer techniques of disinfestations and salvaging of infected material. WTO regulations. Non-tariff barriers. Pest risk analysis and good laboratory practices for pesticide laboratories. Pesticide industry. Sanitary and phytosanitary measures.

Nem.511 Nematode Interaction with Other Organisms **1+1** **Sem.II**

Concept of interaction, its importance in disease complexes and their management involving nematode and other organisms. Interaction of plant parasitic nematodes with wilt causing fungal pathogens. Interaction of plant parasitic nematodes with root rot and other fungal pathogens. Interaction of plant parasitic

nematodes with bacterial pathogens, other nematodes and arthropods. Virus transmission by nematodes. Practical: Green-house experiments to study the role of plant parasitic nematodes in wilt or rot causing fungal and bacterial pathogens.

Nem. 512 Beneficial Nematodes

1+1

Sem.II

Beneficial nematode fauna, predators, parasites of insects, molluscs and other pests; Entomophilic nematodes, their important groups and types of associations. Taxonomic characteristics of nematode parasites of insects. Host-parasite relations and life cycle of mermithids, entaphelenchids, thelastomids, sphaerularids and tylenchids. Steinernema and Heterorhabditis, their morphological characteristics, taxonomic status, biology and mode of action. Entomopathogenic nematodes- mass multiplication techniques, formulations, field applications and efficacy, and commercial products. Nematodes as biological models and as indicators of pollution. Role of nematodes in organic matter recycling.

Practical: Isolation, identification, mass rearing and application methods of entomopathogenic nematodes. Evaluating in vitro survival and on other culture media

Nem. 591 Seminar

Nem. 600 Master's Research

SOIL SCIENCE

PROGRAMMES

1. M.Sc.

2. Ph.D.

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Pedology, Soil Chemistry, Soil Conservation, Soil Fertility, Soil Microbiology, Soil Physics
Required Courses	Soils 501, Soils 502, Soils 503, Soils 504, Soils 505,
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to special interest and research problem
Minor Fields	Agronomy, Biochemistry, Botany, Chemistry, Microbiology, Soil and Water Engineering, Vegetable Science or any other as approved by Dean, postgraduate Studies
Deficiency courses for students with elective other than Soil Science, Agronomy and Agroforestry	9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Pedology, Soil Chemistry, Soil Conservation, Soil Fertility, Soil Microbiology, Soil Physics
Required Courses	Soils 601, Soils 602, Soils 603
Supporting Courses	Courses from subject matter fields (other than minor) relating to area of special interest and research problem
Minor Fields	Agronomy, Biochemistry, Botany, Chemistry, Microbiology, Soil and Water Engineering, Vegetable Science or any other as approved by Dean, postgraduate Studies
Deficiency Courses for students with M.Sc. (Agri.) in a discipline other than Soil Science	Soils 501, Soils 502, Soils 503, Soils 504, Soils 505 and other courses as recommended by Student's Advisory Committee

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Soils 91 Soils-I

2+1

Sem.II

Soil and soil components. Physical properties of soil. Essential plant nutrients. Soil reaction, acidic, saline, alkaline and alkali soils and their reclamation. Organic manures. Soil microorganisms. Chemical fertilizers and bio-fertilizers. Soil and water testing for recommendation purposes. Soil erosion, causes and remedial measures. Soil, air and water pollution.

Practical: Soil sampling for different purposes. Soil profile and its characteristics. Farm yard manure and its preparation. Identification of fertilizers and their application. Visit to soil testing laboratory. Interpretation of soil and water test reports.

Env. 91 Environment-I **3+0** **Sem. I**

Dimensions of environment physical, biological and social. Population and environment. Impact of human activities on environment. Natural resources and their depletion. Agriculture and industry as major sectors of development. Air, water, soil and noise pollution-sources and consequences. Ozone layer depletion and its effect. Greenhouse effect-global warming and climatic changes and their effect on agriculture, plants and animals. Pollution related diseases. Conventional and non - conventional energy sources and their conservation.

Soils 103 Introduction to Soil Science **2+1** **Sem. I**

Concept of land, soil and soil science. Composition of earth crust and its relationship with soils. Rocks and minerals. Weathering. Soil forming factors and processes. Soil profile. Soil colour. Elementary knowledge of taxonomic classification of soils. Soils of Punjab and India. Soil physical properties. Soil texture-textural classes. Soil structure- classification, soil aggregation and significance, soil consistency, soil crusting, bulk density and particle density of soils and porosity, their significance and manipulation. Soil water- retention and potentials. Soil moisture constants. Movement of soil water- infiltration, percolation, permeability, drainage and methods of determination of soil moisture. Thermal properties of soils, soil temperature, Soil air- composition, gaseous exchange, influence of soil temperature and air on plant growth. Soil colloids- properties, nature, types and significance. Sources of charges in clay minerals. Ion exchange, CEC, AEC - factors affecting and adsorption of ions. Soil organic matter- decomposition, mineralization, humus. Carbon cycle, C: N ratio. Soil organisms and their beneficial and harmful roles. Practical: Determination of bulk density and particle density. Aggregate size analysis. Soil moisture determination. Soil moisture constants- field capacity, infiltration rate, water holding capacity, soil mechanical analysis. Analytical chemistry- basic concepts, techniques and calculations, collection and processing of soil samples for analysis of organic carbon, pH, EC, available N, P, K and S. Study of a soil profile. Identification of rocks and minerals.

Soils 104 Soil Chemistry, Soil Fertility and Nutrient Management **2+1** **Sem. II**

Soil as a source of plant nutrients. Essential and beneficial elements- criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants. Factors affecting nutrient availability to plants. Measures to overcome deficiencies and toxicities. Problem soils- acid, salt affected and calcareous soils, characteristics, nutrient availabilities, Reclamation- mechanical, chemical and biological methods. Fertilizer and insecticides and their effect on soil, water and air. Irrigation water- quality of irrigation water and its appraisal. Soil fertility- approaches for soil fertility evaluation. Methods of soil testing. Critical levels of different nutrients in soil. Plant analysis- DRIS approach, critical levels in plants. Rapid tissue tests. Indicator plants. Biological methods of soil fertility evaluation. Soil test based fertilizer recommendations to crops. Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions.

Practical: Principles of analytical instruments and their calibration and applications, Colorimetry and flame photometry. Estimation of available N, P, K, S and Zn in soils. pH, Electrical Conductivity, carbonates, bicarbonates, Ca⁺⁺ and Mg⁺⁺ in soil and water. Lime requirement and gypsum requirement of problem soils. Estimation of N, P and K in plants.

Soils 204 Manures and Fertilizers **1+1** **Sem. II**

Fertilizers - classification, manufacturing processes and properties of major nitrogenous (ammonium sulphate, urea, calcium ammonium nitrate, ammonium nitrate, ammonium sulphate nitrate), phosphatic (single super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate), potassic and complex fertilizers, their fate and reactions in the soil. Secondary and micronutrient fertilizers and amendments. Fertilizer Control Order. Fertilizer storage. Biofertilizers and their advantages. Manures - bulky and concentrated, Farm Yard Manure. Composting - different methods, mechanical compost plants, vermicomposting, green manuring, oil cakes. Sewage and sludge-biogas plant slurry, plant and animal refuges.

Practical: Determination of total nitrogen and phosphorus in manures/composts. Ammonical and nitrate nitrogen, water soluble P₂O₅, potassium, calcium, sulphur and zinc contents of fertilizers. Adulteration in fertilizers. Chemical Oxygen Demand in organic wastes.

Env.301 Environmental Science and Disaster Management **3+0** **Sem. I & II**

Environment - basic concepts and issues. Natural Resources - renewable and non-renewable resources and their sustainable utilization. Ecosystem concepts - types, structure and functions of ecosystem. Pollution of water and air - types, causes, methods of measurement, standards and management. Solid and liquid waste management - treatment and disposal. Vulnerability, adaptability and sustainable development. International conventions and treaties. Biodiversity and conservation - value, utilization and threats. Threatened/endangered species and hotspots. Human population and environment - environment and human health, Environment management laws and conservation projects of Government of India.

Climate change - history and future projections, greenhouse gases, effects and mitigation strategies. Natural Disasters - causes, phenomenon and impacts; Global and national events of disaster management; Agricultural Disaster phenomenon, events and their management; Acts and policies in India.

Undergraduate Elective/M.Sc. Supporting/Minor Courses

Soils 433 Soil Survey, Classification and Mapping **0+2** **Sem. I**

Application and use of global positioning system for soil survey. Macro-morphological study of soils. Classification of soils developed on different landforms. Study of base maps-cadastral maps, toposheets, aerial photographs and satellite imageries. Soil survey of project area- preparation of base maps, analysis of soil characteristics, classification of surveyed soils, mapping and report writing. Interpretation of soil survey data for land capability and crop suitability classifications. Use of geographical information system for preparing thematic maps

Soils 434 Soil Physical and Biological Environment **1+2** **Sem. I**

Soil physical properties in relation to crop production. Soil thermal regime and its management. Soil air - composition, renewal, characterization of soil aeration in relation to plant growth. Movement of water in soil. Infiltration and redistribution of water in soil. Evaporation from soils and its management. Runoff from the agricultural fields and factors affecting. Soil organisms and their distribution, ecology, classification and activities in soil. Microbiological transformations of C, N and S in soils.

Practical: Determination of dry and wet stability of aggregates. Measurement of in situ soil bulk density and filling of soil columns with a particular bulk density. Measurement of soil porosity. Determination of consistency limits of soils. Soil moisture characteristics. Measurement of soil temperature using thermocouples. Determination of infiltration rate under different surface conditions. In situ measurement of soil moisture by neutron probe and Time Domain Reflectometry. In situ measurement of soil matric potential using tensiometers. Enumeration of soil bacteria, fungi and actinomycetes. Isolation of Rhizobium and Azotobacter and measurement of respiration rate.

Soils 435 Analytical Techniques in Soils, Plants, Fertilizers and Water **1+3** **Sem. I**

Colorimetric and flame photometric methods. Atomic absorption spectrophotometry. Cation and anion exchange phenomenon and their importance. Ion adsorption, desorption and fixation in soils. Methods of soil fertility evaluation. Fertilizer control order. Acid, saline, sodic, calcareous soils and their amelioration. Planning and formulation of project on establishment of soil water and plant testing laboratory.

Practical: Preparation of standard solutions. Collection of soil, water, plant and fertilizer samples. Analysis of soil samples for fertility and quality evaluation for field crops and orchard plantations. Analysis of irrigation water for quality appraisal. Fertilizers analysis for quality control. Soil, water and fertilizer analysis reports for recommendation purposes. Analysis of forms of nitrogen, phosphorous, potassium and sulphur in soils. Determination of DTPA- extractable micronutrients. Plant analysis for total N, P, K and micro-nutrients. Determination of CEC and AEC of soils. Nutrient adsorption and fixation capacities of soils.

Postgraduate Courses

Soils 501 Soil Physics **2+1** **Sem. I**

Soil physical behavior. Soil consistence. Dispersion and workability of soils. Soil compaction and consolidation. Soil strength-bulk density relations. Swelling and shrinkage- basic concepts. Soil structure-

genesis, characterization and management. Soil tilth. Soil crusting - mechanism, factors affecting and evaluation. Soil conditioners. Puddling, its effect on soil physical properties. Soil water - retention, constants. Energy state of soil water, soil-moisture characteristics. Hysteresis. Water flow in saturated and unsaturated soils, Darcy's law, hydraulic conductivity, permeability. Infiltration, internal drainage and redistribution. Evaporation. Hydrologic cycle, field water balance. Soil-plant-atmosphere continuum. Composition, renewal and measurement of soil air. Aeration requirement for plant growth. Modes of energy transfer in soils, energy balance, thermal properties of soil. Soil temperature in relation to plant growth.

Practical: Mechanical analysis of soil. Measurement of Atterberg limits. Aggregate analysis. Measurement of soil-water content. Measurement of soil-water potential. 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.

Soils 502 Soil Fertility and Fertilizer Use

2+1

Sem. I

Soil fertility and soil productivity. Nutrient sources - fertilizers and manures. Soil N - sources and N transformations. Biological nitrogen fixation. Nitrogenous fertilizers - their fate in soils and enhancing N use efficiency. Soil P - forms, reactions in soils and factors affecting availability. Management of P fertilizers. Potassium- forms, mechanism of fixation, Q/I relationships. Management of K fertilizers. Sulphur, Ca and Mg - source, forms, fertilizers and their behavior in soils and management. Micronutrients- critical limits in soils and plants, factors affecting their availability, sources and management. Common soil test methods for fertilizer recommendations. Site-specific and plant need based nutrient management. Integrated nutrient management. Blanket fertilizer recommendations- usefulness and limitations. Soil fertility evaluation. Soil quality in relation to sustainable agriculture.

Practical: Laboratory and greenhouse experiments for evaluation of indices of nutrient availability and their critical values in soils and plants. Chemical analysis of soil for total and available nutrients. Analysis of plants for essential elements.

Soils 503 Soil Chemistry

2+1

Sem. I

Chemical composition of earth's crust and soils. Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics. Inorganic and organic colloids-surface charge characteristics, diffuse double layer theories, zeta potential stability, coagulation/ flocculation, peptization, electrometric and sorption properties of soil colloid. Soil organic matter-fractionation, clay-organic interactions. Cation exchange-theories, adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, anion and ligand exchange-inner sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions. Experimental methods to study ion exchange phenomena and practical implications in plant nutrition. Potassium, phosphate and ammonium fixation in soils and management aspects. Chemistry of acid, salt-affected and submerged soils and management aspects

Practical: Analysis of equilibrium soil solution for electrochemical properties. Determination of point of zero-charge and associated surface charge characteristics. Potentiometric and conductometric titration of soil humic and fulvic acids. E4/E6 ratio of soil humic and fulvic acids. Adsorption-desorption of phosphate/ sulphate. Construction of adsorption envelop 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.

Soils 504 Soil Mineralogy, Genesis, Classification and Survey

2+1

Sem. II

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism. Classification, structure, chemical composition and properties of clay minerals. Genesis and transformation of crystalline clay minerals. Amorphous soil constituents and other non-crystalline silicate minerals. Clay minerals in Indian soils. Soil formation - factors, models, processes. Weathering of rocks and mineral transformations. Soil profile. Soil classification systems - historical developments and modern systems of soil classification. Soil survey- types, techniques. Soil series- characterization and procedure for establishing soil series, benchmark soils and soil correlations. Soil survey interpretations. Techniques for generation of soil maps. Landform- soil relationship, major soil groups of India with special reference

to respective states. Land capability and land irrigability classification. Land evaluation and land use type. Approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical: Identification and quantification of minerals in soils. Morphological properties of soil profile in different landforms. Classification of weathering indices and its application in soil formation. Grouping soils using available data base in terms of soil quality. Cartographic techniques for preparation of maps, processing of field sheets, compilation and obstruction of maps in different scales. Land use planning exercises using conventional and RS tools

Soils 505 Soil Biology and Biochemistry

2+1

Sem. II

(Collaboration: Deptt. of Biochemistry)

Soil biota, soil microbial ecology, types of organisms. Soil microbial biomass, microbial interactions, un-culturable soil biota. Microbiology and biochemistry of root-soil interface. Phyllosphere. Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Microbial transformations of N, P, S, Fe and Mn in soil. Biochemical composition and biodegradation of soil organic matter and crop residues. Humus formation. Cycles of important organic nutrients. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Biotic factors in soil development. Microbial toxins in the soil. Preparation and preservation of organic manures, rural and urban composts and vermicompost. Biofertilizers - definition, classification, specifications, method of production and role in crop production.

Practical: Determination of soil microbial population. Soil microbial biomass. Elemental composition, fractionation of organic matter and functional groups. Decomposition of organic matter in soil. Soil enzymes. Measurement of important soil microbial processes such as ammonification, nitrification, N₂ fixation, S oxidation, P solubilization and mineralization of other micro nutrients. Study of rhizosphere effect.

Soils 506 Soil Erosion and Conservation

2+1

Sem. II

History, distribution, identification and description of soil erosion problems in India. Soil erosion by water-factors and mechanism. Raindrops and soil erosion. Rainfall erosivity - estimation of erosivity indices. Soil erosion in relation to soil properties. Wind erosion- factors affecting, extent of problem. Principles and practices of erosion control. Soil conservation planning in hilly, arid and semi-arid regions, waterlogged and wet lands. Type, factors and processes of soil/land degradation and its impact on soil productivity. Watershed management. Water harvesting, recycling and flood control. Socio-economic aspects of watershed management. Case studies in respect to monitoring and evaluation of watersheds. Use of remote sensing in assessment and planning of watersheds.

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 indices (EI₃₀) using rain gauge data. Measurement and estimation of runoff and soil loss. Visits to soil and water conservation works.

Soils 507 Geomorphology and Geochemistry

2+0

Sem. I

General introduction to geology and geochemistry. Major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India. Methodology of geomorphology, its agencies, erosion and weathering. Soil and physiography relationships. Erosion surface of soil landscape. Geochemical classification of elements. Geo- chemical aspects of weathering and migration of elements. Geochemistry of major and micronutrients and trace elements.

Soils 508 Soil, Water and Air Pollution

2+1

Sem. II

Soil, water and air pollution problems associated with agriculture. Nature and sources of pollutants-their CPC standards and effect on plants, animals and human beings. Sewage and industrial effluents - their composition and effect on soil, plant growth and human beings. Soil as sink for waste disposal. Pesticides - their classification, behavior in soil and effect on soil micro- organisms. Toxic elements - their sources, behavior in soils, effect on nutrients availability and on plant and human health. Pollution of water resources. Emission of greenhouse gases. Remediation/amelioration of contaminated soil and water, remote sensing applications in monitoring and management of soil and water pollution to safeguard food safety.

Practical: Sampling of sewage waters and sludge, industrial wastes, polluted soils and plants. Estimation of dissolved and suspended solids, COD, BOD, nitrate and ammonical N and P, heavy metal content in effluents. Heavy metals in contaminated soils and plants. Air sampling and determination of particulate matter and oxides of S. Visit to various industrial sites to study the impact of pollutants on soil and plants.

Soils 509 Analytical Techniques and Instrumental Methods **1+2** **Sem. II**
in Soil and Plant Analysis

Atomic structure. Radioisotopes-properties and decay principles. Principles and use of radiation monitoring instruments. Isotopic dilution techniques. Doses of radiation exposure, radiation safety aspects. Storage and handling of radioactive materials. Principles of visible, ultraviolet and infrared spectrophotometry, inductively coupled plasma spectrometry, chromatographic techniques, mass spectrometry and X-ray diffractometry.

Practical: 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 P and K. Identification of minerals by different methods. Electrochemical titration of clay. Estimation of root CEC. Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo. Analysis of plant materials by digesting plant material by wet and dry ashing and soil by wet digestion methods. Drawing normalized exchange isotherms. Measurement of redox potential. Preparation of soil and plant samples for radioactive measurements. Determination of half life and decay constant.

Soils 510 System Approaches in Soil and Crop Studies **2+0** **Sem. I**

Systems concepts- definitions, general characteristics, general systems theory. Systems - thinking, dynamics, behavior and study. Model - definition and types. Mathematical models and their types. Modeling-concepts, objectives, processes, abstraction techniques. Simulation models, their verification and validation, calibration. Representation of continuous systems simulation models- procedural and declarative. Simulation-meaning and threats, experiment, design and analysis. Application of simulation models in understanding system behavior, 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.

Soils 511 Management of Problem Soils and Water **2+1** **Sem. I**

Area, distribution, origin and basic concepts of problematic soils. Morphological features and characterization of salt-affected soils. Management of salt-affected soils. Salt tolerance of crops - mechanism and ratings. Monitoring of soil salinity in the field. Management principles for sandy, clayey, red lateritic and dry land soils. Acid soils - nature, sources and management. Effect on plant growth. Lime requirement of acid soils. Biological sickness of soils and its management. Quality of irrigation water, management of brackish water. Salt balance under irrigation. Characterization of brackish waters, area and extent. 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 ground water and soil samples. Determination of anions (Cl^- , SO_4^{2-} , CO_3^{2-} and HCO_3^-) in ground waters and soil samples. Lime and gypsum requirement of acid and sodic soil.

Soils 601 Advances in Soil Physics **3+0** **Sem. II**

Soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system. 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. Theories of horizontal and vertical infiltration under different boundary conditions. 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. Thermal properties of soil, heat transfer in soils, differential equation of heat flow, and measurement of thermal conductivity of soil. Structural management of puddled rice soils. Soil conditioners - significance in agriculture. Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems. Prediction of evapotranspiration using aerodynamic and canopy temperature-based models. Leaf diffusion resistance in relation to plant water deficit.

Soils 602 Advances in Soil Fertility **3+0** **Sem. II**

Modern concepts of nutrient availability. Soil solution and plant growth. Nutrient response functions and availability indices. Nutrient movement in soils, absorption by plants. Mechanistic approach models to nutrient supply and uptake by plants. Models for transformation and movement of major micronutrients in soils. Chemical equilibrium involving nutrient ions in soils, particularly in submerged soils. Modern concepts of fertilizer application, evaluation, nutrients use efficiency and nutrient budgeting. Soil fertility evaluation techniques. Role of soil tests in fertilizer use recommendations. Site - specific nutrient management for precision agriculture. Monitoring physical, chemical and biological changes in soils. Permanent manurial trials. Soil productivity under long term intensive cropping- direct, residual and cumulative effects of fertilizer use.

Soils 603 Physical Chemistry of Soils **2+0** **Sem. I**

Colloidal chemistry of inorganic and organic components of soils - their formation, clay organic interaction. Predictive approaches for cation exchange equilibria - thermodynamics, empirical and diffuse double layer theory, relationships among different selectivity coefficients. Structure and properties of diffuse double layer. Thermodynamics of nutrients transformation in soils. Cationic and anionic exchange and their models, molecular interaction. 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. Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate. Electrochemical properties of clays.

Soils 604 Soil Genesis and Micropedology **2+0** **Sem. I**

Pedogenic evolution of soil. Soil composition and characterization. Weathering and soil formation-factors and pedogenic processes. Thermodynamics of mineral stability and weathering sequences of minerals. Assessment of soil profile development by mineralogical and chemical analysis. Micro - pedological features of soils - their structure, fabric analysis, role in genesis and classification.

Soils 605 Biochemistry of Soil Organic Matter **2+0** **Sem. I**

Organic matter- pools, composition and distribution in soils and its functions. Environmental significance of humic substances. Decomposition of organic residues in soil in relation to organic matter pools. Biochemistry of the humus formation and different pathways for humus synthesis in soil. Soil carbohydrates and lipids. Nutrient transformations - N, P, and S. Trace metal interaction with humic substances, Significance of chelation reactions in soils. Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substance in pedogenic soil aggregation processes. Clay-organic matter complexes. Humus - pesticide interaction in soil, mechanisms.

Soils 606 Land Use Evaluation and Planning **2+0** **Sem. II**

Concept and techniques of land use planning. Factors governing present land use. Land evaluation methods and soil-site suitability evaluation for different crops, land capability classification and constraints in application. Agro - ecological regions / sub - regions of India and their characteristics in relation to crop production. Water harvesting - concept, significance, types, methodology and use of harvested water in agriculture to increase water productivity. Watershed development / management - concept, objectives, characterization. Planning, execution, community participation and evaluation. Rehabilitation of watershed. Developing economically and ecologically sustainable agro - forestry systems for watershed through Participatory Rural Appraisal (PRA) and case studies

Soils 591 Seminar

Soils 600 Master's Research

Soils 700 Ph.D. Research

VEGETABLE SCIENCE

PROGRAMMES

1. M.Sc.

2. Ph.D.

COURSE REQUIREMENTS

M.Sc.

Field of Specialization

Required Courses

Supporting Courses

Minor Fields

Deficiency courses for students
with elective other than
Horticulture

Ph.D.

Field of Specialization

Required Courses

Supporting Courses

Minor Fields

Deficiency courses for students
with M.Sc.(Agri.) in a discipline
other than Vegetable Science

Vegetable Breeding, Vegetable Production, Post-harvest Handling

Veg. 501, Veg. 502, Veg. 503, Veg. 504, Veg. 505

Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to the area of special interest and research problem.

Plant Breeding and Genetics, Biotechnology, Botany, Agronomy, Horticulture, Soil Science or any other as approved by Dean, postgraduate Studies.

9-12 credit hours of atleast 400 series courses as recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Vegetable Breeding, Vegetable Production Post-harvest Handling

Veg. 601, Veg. 602, Veg. 603

Courses from subject matter fields (other than minor) relating to area of special interest and research problem.

Plant Breeding and Genetics, Biotechnology, Botany, Agronomy, Horticulture, Soil Science or any other as approved by Dean, postgraduate Studies.

Veg. 501, Veg. 502, Veg. 503, Veg. 504, Veg. 505

and other courses as recommended by Student's Advisory Committee.

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Veg. 101 Vegetable Production Technology **2+1** **Sem. II**

Importance of Olericulture. Vegetable gardens. Vegetable origin, classification, area, production and varieties. Package of practices of tomato, brinjal, chillies and okra. Cucurbitaceous vegetables- cucumber, ridge gourd, ash gourd, snake gourd, bottle gourd, bitter gourd and melons. Cole crops - cabbage, cauliflower and knol-khol. Bulb crops - onion and garlic. Beans and peas - French beans, cluster beans, dolichos beans, peas and cowpea. Tuber crops - potato, sweet potato, tapioca, colocasia, yams. Root crops - carrot, radish, turnip and beet root. Leafy vegetables - amaranthus, palak, methi. Perennial vegetables- drumstick, coccinia and curry leaf.

Practical: Planning and layout of kitchen garden. Identification of important vegetable seeds and plants. Raising of vegetable nurseries. Transplanting of vegetable seedlings in main field. Layout of kitchen garden and its maintenance. Seed extraction in tomato and brinjal. Visit to commercial vegetable farms. Intercultural operations in vegetable plots. Sowing of potato, solanaceous fruit crops, root crops and cucurbitaceous vegetables. Seed production in vegetable crops. Harvesting indices of different vegetable crops. Grading and packing of vegetables.

Undergraduate Elective/M.Sc. Supporting/Minor Courses

Veg. 433 Commercial Vegetable Production **2+1** **Sem. I**

Role of soil, climatic and agronomic factors in vegetable production. Principles of cultivation including direct sowing, nursery management, transplanting, hardening of seedlings and vegetable forcing. Weeds and their control. Rotation and Intercropping in vegetable crops. Export potentiality, post harvest handling, processing, storage and marketing of vegetables. Practical: Sowing and transplanting of vegetable crops. Effect of soil conditions on seedling emergence and plant growth. Nutrient deficiency symptoms. Common weeds, their identification and control. Project formulation and evaluation for vegetable nursery production and vegetable forcing techniques.

Veg. 434 Vegetable Breeding and Seed Production **2+1** **Sem. I**

Scope of vegetable breeding and seed production. Origin, floral biology and breeding systems in vegetable crops. Germplasm resources. Principles and methods of breeding self-pollinated, often cross-pollinated and cross-pollinated vegetable crops. Plant introduction, selection, hybridization, population improvement, mutation and polyploidy. Seed production of conventional varieties. Production of F1 hybrids using male sterility, self-incompatibility, various sex-forms etc. Methods of production of nucleus, breeder, foundation and certified seeds isolation, pollination, seed harvesting, processing and storage. Seed testing and certification. Seed Act. Vegetable seed industry and its problems.

Practical: Study of inflorescence and flower structures. Practice in emasculation and artificial pollination. Inspection and rouging. Testing of seeds for purity and germination. Project formulation and evaluation for seed production of vegetable crops.

Veg. 435 Forcing Techniques in Vegetable Production **2+1** **Sem. I**

Objectives, importance and scope of protected cultivation. Nursery raising techniques. Environmental factors. Vegetable growing media. Irrigation and fertigation. Sustainable land use systems. Maximising land use efficiency in protected structures. Problems of growing vegetables in protected structures, Soil sterilization techniques. Hydroponics cultivation. . Pest management in green house/glass house. Crops and varieties suitable for protected cultivation. Specific technology for raising tomato, sweet pepper, cucumber and high value crops in off season. Cladding material for protected structures - use of mulches. Seed production of vegetables.

Practical: Study of various types of structures. Methods to control temperature, CO₂, light. Demonstration for sanitation measures. Hydroponics. Maintenance of parental lines and hybrid seed production in glasshouse. Fertigation and nutrient management. Control of diseases and insect pests in glasshouse. Visit to established greenhouses in the region.

Postgraduate Courses

Veg. 501 Production Technology of Winter Season Vegetable Crops **2+1** **Sem. I**

Introduction, nutritional value, origin, botany and taxonomy, important countries and states growing vegetables along with area, climate and soil requirements, commercial varieties/hybrids evolved by private and public sector, sowing/ transplanting time, seed rate and seed treatment, nutritional and irrigation requirements, chemical weed control, mulching, physiological disorders, harvesting techniques, post-harvest management, plant protection measures and seed production of potato, cole crops; cabbage, cauliflower, knol khol, broccoli, brussels' sprout, chinese cabbage, root crops; carrot, radish, turnip, beet root, bulb crops; onion and garlic, peas and beans, green leafy cool season vegetables.

Practical: Study of nutrient deficiency symptoms. Experiments on improved water use efficiency through mulching and different irrigation methods. Different methods of weed control and herbicide sprays. Preparation of cropping scheme for commercial farms. Quality evaluation for carotene, protein and ascorbic acid. Visit to an established vegetable farm in the region.

Veg. 502 Production Technology of Summer Season Vegetable Crops **2+1** **Sem. II**

Introduction, nutritional value, origin, botany and taxonomy, important countries and states growing vegetables along with area, climate and soil requirements, commercial varieties/hybrids evolved by private and public sector, sowing/ transplanting time, seed rate, seed treatment, nutritional and irrigation requirements, chemical weed control, mulching, physiological disorders, harvesting techniques, post-harvest management, plant protection measures and seed production of warm season vegetable crops i.e. solanaceous crops, okra, cucurbitaceous crops, cowpea, sweet potato, cluster beans, amaranth, basella, kang-kong, tapioca. Poly-house, net- house and low tunnel technology for off-season production of summer vegetables

Practical: Experiments to demonstrate the role of mineral elements. Fertigation. Chemical weed control. Hybrid seed production of summer vegetables. Use of growth regulators. Seed extraction techniques. Identification of pests and diseases and their control. Forcing techniques for raising summer vegetables. Pruning, grafting and staking. Quality determination for sugar, capsaicin and minerals using atomic absorption.

Veg. 503 Breeding of Self Pollinated and Vegetatively Propagated Vegetable Crops **2+1** **Sem. II**

History of vegetable breeding. Origin, botany, taxonomy, cytogenetic, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), resistance breeding for biotic and abiotic stress, quality improvement in self-pollinated crops viz. tomato, brinjal, cowpea, pea, beans, okra, salad crops and asexually propagated crops like potato, sweet potato, colocasia and tapioca. Molecular marker, marker assisted breeding and QTLs, biotechnology and their use in breeding in self pollinated and vegetatively propagated vegetable crops. Issue of patenting, PPV& FRA. Concept of ideotypes. Present status of varietal/hybrid development in India. New approaches in breeding of self pollinated vegetables.

Practical: Selection of desirable plants from breeding population. Observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations. Induction of flowering. 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 above mentioned crops. Demonstration of sib-mating and mixed population. Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques.

Veg. 504 Breeding of Cross Pollinated Vegetable Crops **2+1** **Sem. I**

History of vegetable breeding. Origin, botany, taxonomy, cytogenetic, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), quality improvement, in cross-pollinated crops viz. capsicum, chilli, cucurbits (muskmelon, watermelon, cucumber, bottle gourd, long

melon, bitter gourd, sponge gourd, summer squash), cole crops (cabbage, cauliflower, broccoli, brussels' sprouts), root crops (carrot radish, turnip), bulb crops (onion, garlic), asparagus, leafy vegetables and spices (black pepper, turmeric, cardamom, coriander). Molecular marker, marker assisted breeding and QTLs, biotechnology and their use in breeding cross pollinated vegetable crops. Present status of varietal/ hybrid development in India. New approaches in breeding of cross pollinated vegetables.

Practical: Selection indices in cole crops, cucurbitaceous crops, bulb crops, root crops, leafy vegetables and spices. Selfing and crossing techniques in cross pollinated vegetable crops. Biometrical analysis - Line x tester analysis, North Carolina Designs, Stability analysis, Triple test cross analysis, generation mean analysis, diallel analysis. Estimation of heritability, heterosis and combining ability.

Veg. 505 Systematics of Vegetable Crops **2+1** **Sem. I**

Principles of classification, different methods of classification, salient features of international code of nomenclature of vegetable crops. Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering self and cross pollinated vegetable crops viz. brinjal chilli, tomato, muskmelon, water melon, bottle gourd, cucumber, bitter gourd, onion, cabbage, cauliflower, carrot, radish, turnip, amaranth, palak, peas, beans, okra and vegetatively propagated vegetables like potato, garlic, sweet potato and spices (turmeric, coriander); cytological level of various vegetable crops, descriptive blanks for describing various varieties of important vegetable crops.

Practical: Identification, description, classification and maintenance of vegetable species and varieties. Survey, collection of allied species and genera locally available. Preparation of keys to the species and varieties. Methods of preparation of herbarium and specimens.

Veg. 506 Seed Production Technology of Vegetable Crops **2+1** **Sem. I**

Definition of seed and its quality; DUS test, scope of vegetable seed industry in India. Agronomical principles and methods of seed production in important vegetable crops; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control. Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

Practical: Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, germination, physical purity) and seed health testing. Notification procedures of varieties. Floral biology. Rouging off-types. Methods of hybrid seed production in important vegetable crops. Seed extraction techniques. Handling of seed processing and seed testing equipments. Visit to seed processing units. Seed testing laboratory and seed production farms.

Veg. 507 Production Technology of Under Exploited Vegetable Crops **2+0** **Sem. I**

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/ planting times and methods, seed rate and treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of asparagus, artichoke, leek, brussels sprout, chinese cabbage, broccoli, kale, amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods), elephant foot, yam, lima bean, winged bean, vegetable pigeon pea, jack bean, sword bean, spine gourd, pointed gourd, oriental pickling melon and little gourd (kundru).

Veg. 508 Organic Vegetable Production Technology **2+1** **Sem. II**

Importance, principles, perspective, concept and component of organic production of vegetable crops. Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic vegetable production; processing and quality control for organic foods. Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchgavya, Biodynamics preparation etc. Pest and disease management in organic farming; ITK's inorganic farming, Role of botanicals and bio-control agents. GAP and GMP -Certification or organic products; organic production and export opportunity and challenges. Organic production of vegetables crops, viz. solanaceous crops, cucurbits, cole crops, root and tuber crops.

Practical: Method of preparation of compost, vermi-composting, biofertilizers, soil solarization. Bio pesticides in horticulture. Green manuring. Mycorrhizae and organic crop production. Water management. Organic soil amendment for root diseases. Weed management in organic horticulture. Visit to organic fields and marketing centers.

Veg. 509 Post-harvest Handling of Vegetable Crops **2+1** **Sem. II**

Determination of maturity in different vegetable crops, assessment of post-harvest losses, pre-harvest methods and practices effecting post-harvest shelf life of vegetables, mechanized harvesting of vegetables, pre-cooling of vegetables using different techniques, post-harvest chemical and non-chemical treatments to enhance shelf life, sorting and grading for packaging, ripening of vegetables, packaging of vegetables including latest techniques like MAP, storage of vegetables including latest techniques like CA storage, food safety and quality, non-destructive methods of quality analysis, quality of raw material for processing, transportation and destination handling, marketing, treatments before shipment and storage, fresh-cut vegetables.

Practical: Practices in judging the maturity of vegetables, harvesting methods and tools. Methods used for pre-cooling and their efficiency measurements. Post-harvest chemical treatments to extend shelf life. Sorting and grading methods. Ripening techniques used in climacteric vegetables. Traditional and latest safe storage techniques. Respiration measurements in harvested produce. Field visit to post-harvest and processing industry.

Veg. 601 Advances in Vegetable Production **3+0** **Sem. II**

Present status and prospects of vegetable cultivation. Nutritional and medicinal values of vegetables. Sustainable vegetable production, Effect of climate on vegetables, Different farming systems used to improve land use efficiency, Choice of varieties/hybrids for maximizing vegetable production. Modern concepts in water nutrient and weed managements like INM, IWM, Drip irrigation etc. Role of growth regulators in vegetables. Cropping systems, Mulching, Hydroponics, Nutrient Film Technique, organic gardening, low cost poly house, net house cultivation for export market. Harvesting, grading, packaging, transportation of vegetables. Post harvest treatment of vegetables.

Veg. 602 Advances in Vegetable Breeding **3+0** **Sem. II**

Evolution, distribution, cytogenetic, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, inter-specific and inter-genetic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, in vitro breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for insect pests, disease, nematode and multiple resistance of Tomato, brinjal, chilli, sweet pepper and potato; cucurbits, cabbage, cauliflower and knol-khol, bhindi, onion, peas, beans, amaranthus, drumstick, carrot, beet root, radish, sweet potato tapioca, elephant foot yam and taro.

Veg. 603 Laboratory Techniques in Vegetable Crops **1+2** **Sem. I**

Use of laboratory equipments for determining the various bio-chemical constituents. Principles and procedures for determination of various biochemical constituents including protein, ascorbic acid, dry matter, colouring matter, beta carotene, lycopene, oleoresin content, capsaicin, sugars (total and reducing), chlorophyll, chromatography, electrophoresis and determination of enzymes relevant to post-harvest handling and processing.

Practical: Determination of sugars (reducing and non-reducing), protein, capsaicin, ascorbic acid, titrable acidity, phenols, O-dihydroxy phenols, carotene and pigments, dry matter, colour, lycopene, colouring matter, texture, oleoresin content, TSS, flavonols, chromatography including TLC, GLC, column chromatography. Electrophoresis, PCR and isolation of plant DNA. Respiration and ethylene measurements.

Veg. 604 Abiotic Stress Management in Vegetable Crops **2+1** **Sem. I**

Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stresses, root stock, use of wild species, use of

anti-transpirant. Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops; Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices. Techniques of vegetable growing under water deficit, water logging, salinity and sodicity. Techniques of vegetable growing under high and low temperature conditions, use of chemicals 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 and use of chemicals for alleviation of different stresses.

Veg. 605 Seed Certification, Processing and Storage of Vegetable Crops **2+1** **Sem. I**

Seed certification, objectives, organization of seed certification, minimum seed certification standards, field inspection, specification for certification; Seed processing, study of seed processing equipments seed cleaning and upgrading, seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number; Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control, Seed testing; ISTA rules for testing, moisture, purity, germination, vigor test, seed sampling, seed viability, seed health testing; seed dormancy, factors responsible for dormancy. Seed marketing, demand forecast, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy, project formulation on vegetable seed production.

Practical: Seed sampling, purity, moisture testing, seed viability, seed vigour tests, seed health testing, seed cleaning, grading and packaging. Handling of seed testing equipment and processing machines. Seed treatment methods, seed priming and pelleting. Field inspection. Practices in rouging. Seed storage. Isolation distances. Mixing and dividing instruments. Biochemical tests. Visit to seed testing laboratories and processing plants. Visit to warehouse to know about sanitation standards.

Veg. 591 Seminar

Veg. 600 Master's Research

Veg. 700 Ph.D. Research

**COURSE CURRICULUM FOR B.Sc. Agri. (Hons.)
4 YEAR PROGRAMME (CORE COURSES)**

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES

				Cr. Hrs.
For PCM base				Th + Pr
1.	Bot.	103	Basic Botany	1 + 1
2.	Zoo.	103	Basic Zoology	1 + 1
				2 + 2 = 4
For PCB base				Th + Pr
1.	Math.	104	Basic Mathematics-I	1 + 1
2.	Math.	108	Basic Mathematics-II	1 + 1
				2 + 2 = 4
Regional Language				
1.	For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level			
	Pbi.	101	Basic Punjabi	0 + 2 (NC)
2.	For ICAR nominees and foreign students			
	Pbi. Cul.	101	Punjabi Culture	2 + 0 (NC)

REQUIRED COURSES

BASIC SCIENCES AND HUMANITIES

1.	Biochem.	201	Elementary Biochemistry	2 + 1
2.	Bot.	206	Crop Physiology	2 + 1
3.	Chem.	302	Chemistry of Agrochemicals, Plant Products and Growth Regulators	1 + 1
4.	Econ.	101	Principles of Agricultural Economics	2 + 0
5.	Econ.	202	Production Economics, Farm Management and Agricultural Finance	1 + 1
6.	Econ.	303	Agricultural Marketing, Trade and Prices	1 + 1
7.	Eng.	102	Comprehension and Communication Skills in English	1 + 2
8.	Micro.	101	Elementary Microbiology	2 + 1
9.	Mgt.	303	Fundamentals of Agri-business Management and Entrepreneurship Development	2 + 0
10.	Stat.	102	Basic Statistics	1 + 1
				15 + 9 = 24

AGRICULTURAL ENGINEERING AND TECHNOLOGY

1.	CSE	101	Introduction to Computer Applications	0 + 2
2.	EST	302	Renewable Energy	1 + 1
3.	FMP	202	Farm Power and Machinery	1 + 1
4.	PFE	304	Protective Cultivation and Post Harvest Technology	1 + 1
5.	SWE	101	Fundamentals of Soil and Water Conservation Engineering	2 + 1
				5 + 6 = 11

AGRICULTURE

1.	Agromet.	102	Introductory Agrometeorology	2+1
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2.	Agron.	106	Water Management and Microirrigation	2+1
3.	Agron.	203	Principles of Agronomy-I (<i>Kharif Crops</i>)	2+1
4.	Agron.	204	Principles of Agronomy -II (<i>Rabi Crops</i>)	2+1
5.	Agron.	205	Organic Farming	1+1
6.	Agron.	301	Practical Crop Production-I (<i>Kharif Crops</i>)	0+2
7.	Agron.	302	Practical Crop Production-II (<i>Rabi Crops</i>)	0+2
8.	Agron.	303	Crop Residue Management	2+0
9.	Biotech.	311	Introduction to Plant Tissue Culture and Genetic Transformation	2+1
10.	Biotech.	312	Introduction to Molecular Biotechnology	2+1
11.	Ent.	204	Fundamentals of Insect Morphology and Systematics	2+1
12.	Ent.	205	Insect Ecology and Integrated Pest Management	2+1
13.	Ent.	302	Insect Pests of Crops and Stored Grains	2+1
14.	Ext.	101	Dimensions of Agricultural Extension	1+1
15.	Ext.	201	Fundamentals of Rural Sociology and Educational Psychology	2+0
16.	Ext.	202	Extension Methodologies and Communication Skills for Transfer of Technology	1+1
17.	Flori.	301	Flower Cultivation and Landscape Gardening	1+1
18.	FT	302	Introduction to Food Science and Post Harvest Value Addition	1+1
19.	Forst.	301	Introductory Forestry	1+1
20.	Hort.	203	Production Technology of Fruit Crops	2+1
21.	Hort.	301	Post Harvest Management of Fruits and Vegetables	1+1
22.	LPM	205	Livestock Production and Management	2+1
23.	PBG	103	Introduction to Genetics	2+1
24.	PBG	202	Principles of Seed Technology	2+1
25.	PBG	303	Introduction to Plant Breeding	2+1
26.	PBG	304	Breeding of Field and Horticultural Crops	2+1
27.	Pl. Path.	101	Plant Pathogens and Principles of Plant Pathology	2+1
28.	Pl. Path.	201	Diseases of Field Crops and their Management	2+1
29.	Pl. Path.	303	Diseases of Horticultural Crops and their Management	2+1
30.	Soils	103	Introduction to Soil Science	2+1
31.	Soils	104	Soil Chemistry, Soil Fertility and Nutrient Management	2+1
32.	Soils	204	Manures and Fertilizers	1+1
33.	Env.	301	Environmental Science and Disaster Management	3+0
34.	Veg.	101	Vegetable Production Technology	2+1
35.	RAWEP and ELP			
i)	RAWEP	401	Village Attachment	0+3
ii)	ELP	401	Specialized Experiential Learning Programme-'Title of Elective ELP'	0+12
iii)	ELP	402	Industrial Attachment (Off-campus)	0+4
iv)	ELP	403	Project Documentation, Report preparation and Evaluation	0+1
36.	Edu. Tour	Educational Tour		0+2 (NC)
				<hr/> 57+53 = 110 + 2 (NC) <hr/>

HOME SCIENCE

1.	HD	106	Human Values in Education	1+1
				<hr/> 1+1=2 <hr/>

ELECTIVE SPECIALISED COURSES

Soil Science, Agronomy and Agroforestry

1.	Soils	433	Soil Survey, Classification and Mapping	0+2
2.	Soils	434	Soil Physical and Biological Environment	1+2
3.	Soils	435	Analytical techniques in Soils, Plants, Fertilizers and Water	1+3
4.	Agron.	433	Weed Management	2+1
5.	Agron.	434	Farming Systems and Sustainable Agriculture	2+1
6.	Agron.	435	Production Technology of Spices, Aromatic, Medicinal and Plantation Crops	2+1
7.	Forst.	433	Production Technology of Economic Forest Trees	2+1

10+11=21

Crop Protection

1.	Ent.	433	Apiculture	1+2
2.	Ent.	434	Biocontrol and Integrated Pest Management	2+2
3.	Ent.	435	Pesticides and Plant Protection Equipment	2+1
4.	Pl. Path.	433	Plant Disease Diagnosis	0+2
5.	Pl. Path.	434	Biocontrol and Integrated Disease Management	2+2
6.	Pl. Path.	435	Post Harvest Diseases and their Management	2+1
7.	Nem.	433	Plant Nematology	1+1

10+11=21

Horticulture

1.	Hort.	433	Nursery Management of Horticultural Crops	2+1
2.	Hort.	434	Commercial Fruit Production	2+1
3.	Hort.	435	Processing and Value Addition of Horticultural Crops	2+1
4.	Veg.	433	Commercial Vegetable Production	2+1
5.	Veg.	434	Vegetable Breeding and Seed Production	2+1
6.	Veg.	435	Forcing Techniques in Vegetable Production	2+1
7.	Flori.	433	Commercial Floriculture and Landscaping	2+1

14+7=21

Plant Breeding, Genetics and Biotechnology

1.	PBG	433	Genetics of Crop Plants	2+1
2.	PBG	434	Cytogenetics of Crop Plants	2+1
3.	PBG	435	Theory and Practice of Plant Breeding	3+1
4.	PBG	436	Breeding of Field Crops	3+0
5.	PBG	437	Crop Experimentation	1+1
6.	Biotech.	433	Principles and Procedures of Plant Tissue Culture and Transformation	2+1
7.	Biotech.	434	Principles and Procedures of Molecular Biotechnology and Genomics	2+1

15+6=21

Post Harvest Technology and Value Addition

1.	Biochem.	428	Fundamentals of Food Biochemistry	2+0
2.	FT	433	Fruit and Vegetable Technology	2+1
3.	FT	434	Dairy Technology	2+1
4.	FT	435	Cereal Technology	2+1

5.	FT	436	Egg and Meat Technology	2+1
6.	Micro.	433	Fundamentals of Food Microbiology	2+1
7.	PFE	433	Engineering Principles in Food Processing	3+1
				15+6=21

Agricultural Extension, Economics and Business Management

1.	Ext.	433	Visual and Graphic Communication	1+1
2.	Ext.	434	Communication and Information Technology	2+1
3.	Ext.	435	Behavioural Skills for Human Resource Development	2+0
4.	Econ.	433	Micro Economic Analysis	3+1
5.	Econ.	434	Macro Economic Analysis	3+0
6.	Mgt.	433	Financial and Project Management	3+1
7.	Mgt.	434	Retailing and Supply Chain Management	3+0
				17+4=21

NCC/ NSO/NSS (Three Fold Programme)

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. Agri. (Hons.) Programme 172+ 6 (NC)+2(NC)*

* Students opting for Pbi. 101/Pbi. Cul. 101

**SEMESTER-WISE STUDY PROGRAMME OF
B.Sc. Agri. (Hons.) 4 YEAR PROGRAMME**

FIRST YEAR

SEM I			SEM II		
1. Agromet.	102	2+1	1. Agron.	106	2+1
2. Eng.	102	1+2	2. CSE	101	0+2
3. Micro.	101	2+1	3. Econ.	101	2+0
4. PBG	103	2+1	4. Ext.	101	1+1
5. Pbi /	101	0+2 (NC)*	5. Pl. Path.	101	2+1
Pbi. Cul.	101	2+0 (NC)*	6. Soils	104	2+1
6. Soils	103	2+1	6. Stat.	102	1+1
7. Bot./	103		8. Veg.	101	2+1
Math.	104	1+1	9. Zoo./	103	
8. SWE	101	2+1	Math.	108	1+1
9. NCC/ NSO/NSS		0+1(NC)	10. NCC/ NSO/NSS		0+1(NC)
12+8 = 20 +1(NC)			13+9=22+ 1(NC)		

SECOND YEAR

SEM III			SEM IV		
1. Agron.	203	2+1	1. Agron.	204	2+1
2. Bot.	206	2+1	2. Agron.	205	1+1
3. Ent.	204	2+1	3. Econ.	202	1+1
4. Ext.	201	2+0	4. Ent.	205	2+1
5. FMP	202	1+1	5. Ext.	202	1+1
6. Hort.	203	2+1	6. LPM	205	2+1
7. Pl. Path.	201	2+1	7. Soils	204	1+1
8. HD	106	1+1	8. PBG	202	2+1
9. NCC/ NSO/NSS		0+1(NC)	9. NCC/ NSO/NSS		0+1(NC)
		14+7=21+1(NC)			12+8=20+1(NC)

THIRD YEAR

SEM V			SEM VI		
1. Agron.	301	0+2	1. Agron.	302	0+2
2. Biotech.	311	2+1	2. Agron.	303	2+0
3. Chem.	302	1+1	3. Mgt.	303	2+0
4. Econ.	303	1+1	4. EST	302	1+1
5. Ent.	302	2+1	5. Flori.	301	1+1
6. FT	302	1+1	6. Pl. Path.	303	2+1
7. Forst.	301	1+1	7. PBG	304	2+1
8. Biochem.	201	2+1	8. PFE	304	1+1
9. PBG	303	2+1	9. Env.	301	3+0
10. Edu.Tour		0+2 (NC)	10. Hort.	301	1+1
		12+10= 22+2(NC)			15+8=23

FOURTH YEAR

SEM VII		SEM VIII		
1. Elective 21 (Elective Specialized Courses)		1. RAWEP AND ELP		0+20
2. Biotech. 312	2+1	i)	RAWEP	401 0+3
		ii)	ELP	401 0+12
		iii)	ELP	402 0+4
		iv)	ELP	403 0+1
	<u>24</u>			

**SEMESTER VIII. RAWEP-CUM-EXPERIENTIAL LEARNING PROGRAMME
(20 WEEKS PERIOD, 20 CREDIT HOURS:0+20)**

ELP 401. Specialized Experiential Learning Programme -

Title of Module

(On-Campus) (0+12) 12 weeks

Elective-wise 'Experiential Learning Programme (ELP)

Modules':

ELP 402. Industrial Attachment

(Off-Campus) (0+4) 4 weeks

ELP 401-based 'Experiential Learning Programme

(ELP)' Modules':

1. Elective: Soils, Agronomy and Agroforestry

Module for evaluating soil health and irrigation water quality
(Deptt. of Soil Science)

Practical seed production
(Deptt. of Agronomy)

Nursery production of important agro-forestry tree species
(Deptt. of Forestry and Natural Resources)

2. Elective: Crop Protection

Production of bioagents against plant pathogens

Production of important parasitoids and arthropod predators as
bioagents against insect-pests of important field crops
(Deptt. of Entomology)

Commercial apiculture
(Deptt. of Entomology)

3. Elective: Horticulture

Nursery production of fruit crops
(Deptt. of Fruit Science)

Nursery raising techniques and protected cultivation of
vegetables
(Deptt. of Vegetable Science)

Nursery raising of flowers and ornamental plants
(Deptt. of Floriculture and Landscaping)

Mushroom production (Deptt. of Microbiology)

- (i) Fertilizer industries (IFFCO, KRIBHCO, NFL, etc.)
- (ii) Vermicompost units
- (iii) Biofertilizer units
- v) Mineral mines

- (i) Seed industries / companies
- (ii) Mentha distillation plants
- (iii) Herbicide formulators
- (iv) Soybean processing units

- (i) Plywood manufacturing industries
- (ii) Hi-tech industry (tree planting stock production)

- (i) Pesticide and biopesticide industries
(Deptt. of Plant Pathology)
- (ii) Biocontrol agents production units
- (iii) Plant Quarantine Station
- (iv) Virus free potato tubers production units

- (i) Pesticide and biopesticide industries
- (ii) Biocontrol agents production units
- (iii) Plant Quarantine Station

- (i) Sericulture units
- (ii) Commercial honey production, hive and other
apicultural equipment and honey processing plant
manufacturing units, honey trading, processing, testing,
packaging, exporting and marketing units

- (i) Commercial fruit nurseries
- (ii) Fruit Research Sub-stations, Gangian, Jallowal-Lesriwal
& Bahadurgarh; Research Stations, Bathinda & Gurdaspur;
Regional Research Station, Abohar and Institute of Agriculture,
Gurdaspur

- (i) Commercial vegetable nurseries
- (ii) Farms of Progressive vegetable growers

- (i) Commercial flower nurseries
- (ii) Flower marketing firms
- (iii) Flower seed production and landscaping units

- (i) Mushroom production units

4. Elective: Plant Breeding, Genetics and Biotechnology

Hybrid seed production of sunflower
(Deptt. of Plant Breeding and Genetics)

- (i) Commercial hybrid seed production units
- (ii) Hybrid seed production units at University Seed Farms (Naraingarh, Nabha, Kapurthala, Faridkot and Ladhowal)

Biotechnological tools in crop improvement
(School of Agricultural Biotechnology)

- (i) Biotechnological industries and tissue culture labs

5. Elective: Post Harvest Technology and Value Addition

Production of value added processed food products
(Deptt. of Food Science and Technology)

- (i) Food processing and packaging industries

6. Elective: Agricultural Extension, Economics and Business Management

Designing and preparation of facilitating material and organizing activities
(Deptt. of Extension Education)

- (i) Non-governmental organizations and SHGs to study their mandate, activities and problems, etc. and extension services provided by CAO, Deputy Director (Horticulture), Soil Conservation, PAMETI, ATMA, IFFCO, KRIBHCO, MARKFED, DRDA, Zila Parishad, etc.

Marketing of agricultural produce, preparing enterprise & financial budgets and identification of adoption gaps
(Deptt. of Agric. Economics and Sociology)

- (ii) Agricultural Financial Institutions / branches of Commercial Banks / Co-operative Banks, Co-operative Agricultural Service Societies (CASS), market committees

Case studies related to financial, project, retail and supply chain management, and preparation of project profile
(School of Business Studies)

- (iii) Agri-business industry in Public/ Private sector to study Agri-business Management practices/processes

Students opting for a particular elective programme will opt for any one module i.e. ELP 401 within the elective and will opt for only one corresponding module. as listed under ELP 402.

ELP 403. Documentation, Report Presentation and Evaluation (On-Campus) (0+1) 1 week, based on corresponding ELP 401 & ELP 402.

RAWEP : 13 Credit hours

Elective : 21 Credit hours

ELP : 17 Credit hours

I. RAWE Courses/ RAWEP

Semester I.

NCC/NSO/NSS: 1 Credit hour (0+1 NC)

Semester II.

NCC/NSO/NSS: 1 Credit hour (0+1 NC)

Semester III.

NCC/NSO/NSS: 1 Credit hour (0+1 NC)

Semester IV.

NCC/NSO/NSS: 1 Credit hour (0+1 NC)

Semester V.

Agron. 301: Practical Crop Production -I (*Kharif Crops*): 2 Credit hours (0+2)

Edu. Tour: Educational Tour: 2 Credit hours (0+2 NC)

Semester VI.

Agron. 302. Practical Crop Production -II (*Rabi Crops*): 2 Credit hours (0+2)

Semester VII.

Elective courses: 21 Credit hours

Semester VIII.

RAWEP 401: 'Village Attachment': 3 weeks, 3 Credit hours (0+3)

I. Rural Awareness Work Experience

RAWEP 401: 'Village Attachment': 3 weeks, 3 Credit hours (0+3) (Coordinator : Head, Department of Extension Education)

II. Experiential Learning Programme

ELP 401: 'Specialized Experiential Learning Programme - **TITLE OF ELECTIVE ELP*****: 12 weeks, 12 Credit hours, On-campus activity (0+12)

ELP 402: 'Industrial Attachment': 4 weeks, 4 Credit hours, Off-campus activity (0+4)

ELP 403: 'Documentation and Report Presentation & Evaluation', 1 week, 1 Credit hour (0+1)

TOTAL CREDIT HOURS REQUIREMENT FOR B.Sc. Agri. (Hons.) PROGRAMME 172+ 6 (NC)+2(NC)*

* Students opting for Pbi. 101/Pbi. Cul. 101

** Students have to fill the appropriate title in their Registration Cards

COURSE CURRICULUM FOR B.Sc. Agri. (Hons.) 6 YEAR PROGRAMME FOR FIRST TWO YEARS

CORE COURSES

BASIC SCIENCES AND HUMANITIES

1.	Bot. 91	Botany-I	3+1
2.	Bot. 92	Botany-II	3+1
3.	Chem.91	Chemistry-I	3+1
4.	Chem.92	Chemistry-II	3+1
5.	Eng. 91	English-I	2+1
6.	Eng. 92	English-II	2+1
7.	Pbi. 91	Punjabi-I	2+1
8.	Pbi. 92	Punjabi-II	2+1
9.	Phys. 91	Physics-I	3+1
10.	Phys. 92	Physics-II	3+1
11.	Zoo. 91	Zoology-I	3+1
12.	Zoo. 92	Zoology-II	3+1

32+12=44

AGRICULTUE

1.	Agron. 91	Agronomy-I	2+1
2.	Env. 91	Environment-I	3+0
3.	Ent - Pl.Path. 91	Plant Protection-I	2+1
4.	Ext. 91	Extension-I	2+0
5.	Hort. 91	Horticulture-I	2+1
6.	LPM. 91	Animal Science-I	2+1
7.	Ort. 91	Orientation	0+1(NC)
8.	PFT 91	Practical Field Training-I	0+1
9.	PFT 92	Practical Field Training-II	0+1
10.	Soils 91	Soils-I	2+1

15+7=22 +1(NC)

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)

Note:

1. All courses approved for B.Sc. Agri. (Hons.) 4-year Programme by Academic Council will also be applicable to B.Sc. Agri. (Hons.) 6-year Programme from 3rd year onwards
2. However, the students of B.Sc. Agri. (Hons.) 6- year programme will be exempted from:
 - (a) NCC/ NSO/NSS (0+1NC), which they have already cleared during initial two years,
 - (b) Pbi. 101 (0+2NC), Bot 103 (1+1) and Zoo 103 (1+1) courses, because they have already cleared 6 credit hours in Punjabi (Pbi. 91 and Pbi. 92) and 8 credit hours each in Botany (Bot. 91 and Bot. 92) and Zoology (Zoo. 91 and Zoo. 92) during initial two years which are equivalent to 10+2 medical stream.

3. The students who join 3rd year of B.Sc. Agri. (Hons.) 6-year Programme after completion of 2- Year Certificate Course in Agriucture will be exempted from:
- Agromet. 102 (2+1), Agron.106 (2+1), Pl. Path. 101 (2+1) and Soils 103 (2+1) courses, which they have already cleared during '2-Year Certificate Course in Agriucture'
 - Pbi. 101 (0+2NC), Bot. 103 (1+1) and Zoo. 103 (1+1) courses, because they have already cleared 6 credit hours in Punjabi (Pbi. 91 and Pbi. 92) and 8 credit hours each in Botany (Bot.91 and Bot. 92) and Zoology (Zoo. 91 and Zoo. 92) during initial two years which are equivalent to 10+2 medical stream.
4. The students who join 3rd year of B.Sc. Agri. (Hons.) 6-year Programme after completion of '2- Year Certificate Course in Agriucture' will take Chem. 91 (3+1), Chem. 92 (3+1), Phys. 91 (3+1), Phys. 92 (3+1) and NCC/ NSO/NSS (0+1) courses, which are not included in the Course Curriculum of '2-Year Certificate Course in Agriucture' programme.

SEMESTER-WISE STUDY PROGRAMME OF B.Sc. Agri. (Hons.) 6-YEAR PROGRAMME FOR FIRST TWO YEARS

FIRST YEAR

SEM I			SEM II		
1. Agron.	91	2+1	1. Chem.	92	3+1
2. Bot.	91	3+1	2. Eng.	92	2+1
3. Chem.	91	3+1	3. Phys.	91	3+1
4. Eng.	91	2+1	4. Soils	91	2+1
5. Ort.	91	0+1(NC)	5. Zoo.	91	3+1
6. Pbi.	91	2+1	6. NCC/NSO /NSS		0+1(NC)
7. NCC/NSO /NSS		0+1(NC)			<u>13+5=18+1(NC)</u>
		<u>12+5=17+2 (NC)</u>			

SECOND YEAR

SEM III			SEM IV		
1. Env.	91	3+0	1. Bot.	92	3+1
2. Hort.	91	2+1	2. Pbi.	92	2+1
3. LPM	91	2+1	3. Ext.	91	2+0
4. Phys.	92	3+1	4. Zoo.	92	3+1
5. Ent.-Pl.Path.	91	2+1	5. PFT	92	0+1
6. PFT	91	0+1	6. NCC/NSO /NSS		0+1(NC)
7. NCC/NSO /NSS		0+1(NC)			<u>10+4=14+1(NC)</u>
		<u>12+5=17+1(NC)</u>			

Note:

- All courses approved for B.Sc. Agri. (Hons.) 4-year Programme by Academic Council will also be applicable to B.Sc. Agri. (Hons.) 6-year Programme from 3rd year onwards
- However, the students of B.Sc. Agri. (Hons.) 6-year programme will be exempted from: NCC/NSO /NSS (0+1NC), which they have already cleared during initial two years. The students will also be exempted from Pbi. 101 (0+2NC), Bot 103 (1+1) and Zoo 103 (1+1) courses, because they have already cleared 6 credit.
- 10A Bathinda and Gurdaspur students will register for three fold programme during then 3rd and 4th at PAU Ludhiana campus.

COURSE CURRICULUM FOR B.Tech. FOOD TECHNOLOGY 4 YEAR PROGRAMME (CORE COURSES)

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES

				Cr. Hrs.
For PCM base				Th + Pr
1.	Bot.	103	Basic Botany	1 + 1
2.	Zoo.	103	Basic Zoology	1 + 1
				2 + 2 = 4
For PCB base				Th + Pr
1.	Math.	104	Basic Mathematics-I	1 + 1
2.	Math.	108	Basic Mathematics-II	1 + 1
				2 + 2 = 4
Regional Language				
1.	For students with domicile of Punjab who have not taken Punjabi at Matric/ 10+ 2 level			
	Pbi.	101	Basic Punjabi	0 + 2 (NC)
2.	For ICAR nominees and foreign student			
	Pbi. Cul.	101	Punjabi Culture	2 + 0 (NC)

REQUIRED COURSES

BASIC SCIENCES AND HUMANITIES

1.	Biochem.	201	Elementary Biochemistry	2+1
2.	Biochem.	424	Experiments in Biochemistry	0+3
3.	Biochem.	428	Fundamentals of Food Biochemistry	2+0
4.	Econ.	101	Principles of Agricultural Economics	2+0
5.	Econ.	303	Agricultural Marketing, Trade and Prices	1+1
6.	Econ.	428	Practices in Project Planing and Evaluation	0+3
7.	Eng.	102	Comprehension and Communication Skills in English	1+2
8.	Math.	211	Engineering Mathematics-I	2+1
9.	Math.	212	Engineering Mathematics-II	2+1
10.	Mgt.	303	Fundamentals of Agribusiness Management and Entrepreneurship Development	3+0
11.	Mgt.	423	Introduction to Entrepreneurship and Marketing	2+1
12.	Micro.	101	Elementary Microbiology	2+1
13.	Micro.	424	Fermentation and Industrial Microbiology	2+1
14.	Micro.	433	Fundamentals of Food Microbiology	2+1
15.	Stat.	102	Basic Statistics	1+1
				24+17=41

AGRICULTURE

1.	Agromet.	102	Introductory Agrometeorology	2+1
2.	Agron.	101	Elements of Agronomy	2+1
3.	Biotech.	102	Food Biotechnology	2+1
4.	Ext.	202	Extension Methodologies and Communication Skills for Transfer of Technology	1+1
5.	Env.	301	Environmental Science and Disaster Management	3+0
6.	FT	101	Food Production Trends and Programmes	2+0
7.	FT	102	Principles of Food Processing and Preservation	2+1
8.	FT	201	Technology of Fish and Marine Foods	1+1

9.	FT	202	Food Quality	1+1
10.	FT	203	Food Packaging	2+1
11.	FT	204	Technology of Extruded Food Products	2+1
12.	FT	303	Food Additives	2+1
13.	FT	304	Food Industry By-products	1+1
14.	FT	305	Food Safety, Laws and Regulation	2+1
15.	FT	306	Speciality Foods	1+1
16.	FT	307	Technology of Food Beverages	1+1
17.	FT	401	Quality Assurance and Certification	2+1
18.	FT	402	Confectionery and Bakery Technology	2+1
19.	FT	403	Technology of Legumes and Oilseeds	2+1
20.	FT	404	Technology of Plantation Crops and Spices	1+1
21.	FT	433	Fruit and Vegetable Technology	2+1
22.	FT	434	Dairy Technology	2+1
23.	FT	435	Cereal Technology	2+1
24.	FT	436	Egg and Meat Technology	2+1
25.	FT	491	B.Tech. Seminar	0+1
26.	FT	499	Industrial Training	0+20
27.	Hort.	301	Post-harvest Management of Fruits and Vegetables	1+1
28.	Edu. Tour		Educational Tour	0+2(NC)
				<hr/>
				43+44=87+2(NC)

AGRICULTURAL ENGINEERING & TECHNOLOGY

1.	CSE	101	Introduction to Computer Application	0+2
2.	CSE	104	IT Application in Food Industry	1+1
3.	EST	302	Renewable Energy	1+1
4.	ME	103	Engineering Drawing	0+2
5.	ME	106	Thermodynamics	2+0
6.	ME	205	Workshop Technology	2+1
7.	ME	206	Heat and Mass Transfer	2+0
8.	ME	303	Fluid Mechanics	2+1
9.	ME	311	Instrumentation and Process Control	2+1
10.	PFE	211	Food Processing Equipment-I	2+1
11.	PFE	311	Food Processing Equipment-II	2+1
12.	PFE	312	Food Plant Design and Layout	1+2
13.	PFE	407	Waste and By-Product Utilization	2+1
				<hr/>
				19+14=33

HOME SCIENCE

1.	FN	103	Principles of Human Nutrition	2+1
2.	HD	106	Human Values in Education	1+1
				<hr/>
				3+2=5

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

170+6(NC)+2(NC)*

* Students opting for Pbi. 101/Pbi. Cul. 101

**SEMESTER-WISW STUDY PROGRAMME OF
B.Tech. FOOD TECHNOLOGY 4 YEAR PROGRAMME**

FIRST YEAR

SEM I			SEM II		
1. Agron.	101	2+1	1. Micro.	101	2+1
2. Agromet.	102	2+1	2. Biochem.	201	2+1
3. Eng.	102	1+2	3. FN	103	2+1
4. Econ.	101	2+0	4. FT	102	2+1
5. FT	101	2+0	5. ME	106	2+0
6. ME	103	0+2	6. CSE	104	1+1
7. CSE	101	0+2	7. Bot./	103	1+1
8. Zoo./	103/		Math.	108	
Math.	104	1+1	8. Stat.	102	1+1
9. Pbi. /	101/	0+2 (NC)*	9. HD	106	1+1
Pbi. Cul.	101	2+0 (NC)*	10. NCC/NSO/NSS		0+1(NC)
10. NCC/NSO/NSS		0+1 (NC)			<u>14+8=22+1 (NC)</u>
		<u>10+9=19+1 (NC)</u>			

SECOND YEAR

SEM III			SEM IV		
1. EST	302	1+1	1. FT	203	2+1
2. Env.	301	3+0	2. FT	204	2+1
3. Biotech.	102	2+1	3. Econ.	303	1+1
4. ME	205	2+1	4. ME	206	2+0
5. FT	201	1+1	5. ME	303	2+1
6. FT	202	1+1	6. Math.	212	2+1
7. Math.	211	2+1	7. PFE	211	2+1
8. Ext.	202	1+1	8. NCC/NSO/NSS		0+1 (NC)
9. NCC/NSO/NSS		0+1 (NC)			<u>13+6=19+1 (NC)</u>
		<u>13+7=20+1 (NC)</u>			

THIRD YEAR

SEM V			SEM VI		
1. Biochem.	424	0+3	1. FT	306	1+1
2. Micro.	433	2+1	2. FT	307	1+1
3. ME	311	2+1	3. FT	401	2+1
4. FT	303	2+1	4. Micro.	424	2+1
5. FT	304	1+1	5. Biochem.	428	2+0
6. FT	305	2+1	6. Mgt.	303	3+0
7. Hort.	301	1+1	7. PFE	312	1+2
8. PFE	311	2+1	8. PFE	407	2+1
9. Edu. Tour		0+2 (NC)	9. Econ.	428	0+3
		$12+10=22+2(\text{NC})$			$14+10=24$

FOUR YEAR

SEM VII			SEM VIII		
1. FT	402	2+1	1. FT	499	0+20
2. FT	403	2+1			0+20= 20
3. FT	404	1+1			
4. FT	433	2+1			
5. FT	434	2+1			
6. FT	435	2+1			
7. FT	436	2+1			
8. FT	491	0+1			
9 Mgt.	423	2+1			
		$15+9=24$			

COURSE CURRICULUM FOR B.Sc. BIOTECHNOLOGY (Hons.) 4-YEAR PROGRAMME (CORE COURSES)

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES

For PCM base		Cr. Hrs.
		Th + Pr
1.	Bot. 103 Basic Botany	1 + 1
2.	Zoo 103 General Zoology	1 + 1
		2 + 2 = 4
For PCB base		Th + Pr
1.	Math. 104 Basic Mathematics-I	1 + 1
2.	Math. 108 Basic Mathematics-II	1 + 1
		2 + 2 = 4
Regional Language		
1.	For students with domicile of Punjab who have not taken Punjabi at Matric/10+ 2 level Pbi. 101 Basic Punjabi	0 + 2 (NC)
2.	For ICAR nominees and foreign student Pbi. Cul. 101 Punjabi Culture	2+0 (NC)

REQUIRED COURSES

AGRICULTURE

1.	Agromet. 102	Introductory Agrometeorology	2+1
2.	Agron. 101	Elements of Agronomy	2+1
3.	Biotech. 101	Introduction to Biotechnology	2+1
4.	Biotech. 301	Fundamentals of Recombinant DNA	3+1
5.	Biotech. 302	Introduction to Plant Tissue Culture	2+1
6.	Biotech. 303	Introduction to Nanobiotechnology	2+0
7.	Biotech. 304/ Micro. 303	Introduction to Industrial Biotechnology	2+1
8.	Biotech. 305	Introduction to Molecular Biology	2+0
9.	Biotech. 306	Introduction to Molecular Genetics	2+0
10.	Biotech. 307	Introduction to Bioinformatics	2+1
11.	Biotech. 308	Instrumentation in Biotechnology	0+2
12.	Biotech. 309	Introduction to Cell Biology	2+1
13.	Biotech. 313	Environmental Biotechnology	2+0
14.	Biotech. 401	Introduction to Genomics and Proteomics	3+0
15.	Biotech. 402	Fundamentals of Cytogenetics and Molecular Cytogenetics	2+1
16.	Biotech. 403	Techniques in Molecular Biology	0+2
17.	Biotech. 404	Computational Biology	3+1
18.	Biotech. 406	Functional Genomics	2+0

19.	Biotech.	433	Principles and Procedures of Plant Tissue Culture and Transformation	2+1
20.	Biotech.	434	Principles and Procedures of Molecular Biotechnology and Genomics	2+1
21.	Biotech.	499	In-house Project Training	0+20
22.	Ent.	201	Introductory Entomology	2+1
23.	Env.	301	Environmental Science and Disaster Management	3+0
24.	Ext.	202	Extension Methodologies and Communication Skills for Transfer of Technology	1+1
25.	Flori.	301	Flower Cultivation and Landscape Gardening	1+1
26.	Forst.	301	Introductory Forestry	1+1
27.	FT	101	Food Production Trends and Programmes	2+0
28.	FT	302	Introduction to Food Science and Post-harvest Value Addition	1+1
29.	Hort.	203	Production Technology of Fruit Crops	2+1
30.	PBG	103	Introduction to Genetics	2+1
31.	PBG	433	Genetics of Crop Plants	2+1
32.	PBG	435	Theory and Practices of Plant Breeding	3+1
33.	Pl.Path.	101	Plant Pathogens and Principles of Plant Pathology	2+1
34.	Soils	103	Introduction to Soil Science	2+1
35.	Veg.	101	Vegetable Production Technology	2+1
36.	Edu. Tour		Educational Tour	0+2 (NC)
				65+48=113+2(NC)

AGRICULTURAL ENGINEERING AND TECHNOLOGY

1.	CE	404	Environmental Engineering	2+1
2.	CSE	101	Introduction to Computer Applications	0+2
				2+3=5

BASIC SCIENCES AND HUMANITIES

1.	Biochem.	201	Elementary Biochemistry	2+1
2.	Biochem.	301	Introduction to Molecular Biochemistry	3+0
2.	Biochem.	421	Fundamentals of Biochemistry	3+0
3.	Bot.	206	Crop Physiology	2+1
4.	Bot.	422	Photosynthesis, Respiration and Metabolism	2+1
5.	Chem.	203	Physical and Inorganic Chemistry	2+1
6.	Chem.	204	Mechanism of Organic Reactions	2+1
7.	Econ.	101	Principles of Agricultural Economics	2+0
8.	Eng.	102	Comprehension and Communication Skills in English	1+2
9.	Math.	203	Biomathematics	2+1
10.	Mgt.	401	Fundamentals of Agribusiness Management	2+0
11.	Micro.	101	Elementary Microbiology	2+1
11.	Micro.	422	Microbial Genetics	2+1
12.	Stat.	102	Basic Statistics	1+1
13.	Stat.	202	Biostatistics	2+1
14.	Zoo.	303	Fundamentals of Animal Biotechnology and Immunology	3+1
				33+13=46

HOME SCIENCE

1. HD 106 Human Values in Education

1+1

1+1=2

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.Sc. Biotechnology (Hons.) 4 year Programme

170+6 (NC)+2(NC)*

* Students opting for Pbi. 101/Pbi. Cul. 101

**SEMESTER-WISE STUDY PROGRAMME OF B.Sc. BIOTECHNOLOGY (Hons.)
4-YEAR PROGRAMME**

FIRST YEAR

SEM I			SEM II		
1. Biotech.	101	2+1	1. Pl.Path.	101	2+1
2. PBG	103	2+1	2. Zoo.	103	
3. Bot.	103		Math.	108	1+1
Math.	104	1+1	3. FT	101	2+0
4. Biochem.	201	2+1	4. Chem.	203	2+1
5. Agron.	101	2+1	5. Stat.	102	1+1
6. Eng.	102	1+2	6. Econ.	101	2+0
7. Micro.	101	2+1	7. Biotech.	301	3+1
8. Pbi.	101/	0+2 (NC)	8. HD	106	1+1
Pbi Cul.	101	2+0 (NC)	9. Env.	301	3+0
9. NCC/NSO/NSS		0+1 (NC)	10. NCC/NSO/NSS		0+1 (NC)
		<u>12+8= 20+3 (NC)</u>			<u>17+6= 23 + 1 (NC)</u>

SECOND YEAR

SEM III			SEM IV		
1. Forst.	301	1+1	1. FT.	302	1+1
2. Biotech.	302	2+1	2. Flori.	301	1+1
3. Ent.	201	2+1	3. Bot.	206	2+1
4. Hort.	203	2+1	4. Veg.	101	2+1
5. Soils	103	2+1	5. CSE	101	0+2
6. Stat.	202	2+1	6. Chem.	204	2+1
7. Ext.	202	1+1	7. Agromet.	102	2+1
8. Math.	203	2+1	8. Biotech./Micro.	304/303	2+1
9. NCC/NSO/NSS		0+1 (NC)	9. NCC/NSO/NSS		0+1(NC)
		<u>14+8=22+1(NC)</u>			<u>12+9=21+1(NC)</u>

THIRD YEAR

SEM V			SEM VI		
1. Zoo.	303	3+1	1. Biotech.	305	2+0
2. Biotech.	303	2+0	2. Biotech.	306	2+0
3. Bot.	422	2+1	3. Biotech.	307	2+1
4. CE	404	2+1	4. Biotech.	308	0+2
5. PBG	433	2+1	5. Biotech.	309	2+1
6. PBG	435	3+1	6. Biotech.	313	2+0
7. Biochem.	301	3+0	7. Biochem.	421	3+0
8. Edu. Tour	0+2 (NC)		8. Micro.	422	2+1
	<u>17+5= 22+2(NC)</u>		9. Mgt.	401	<u>2+0</u>
					17+5= 22

FOURTH YEAR

SEM I			SEM II		
1. Biotech.	401	3+0	1. Biotech.	499	0+20
2. Biotech.	402	2+1			0+20=20
3. Biotech.	403	0+2			
4. Biotech.	404	3+1			
5. Biotech.	406	2+0			
6. Biotech.	433	2+1			
7. Biotech.	434	2+1			
		<u>14+6=20</u>			

COURSE CURRICULUM FOR '2 YEAR CERTIFICATE COURSE IN AGRICULTURE'

CORE COURSES

BASIC SCIENCES AND HUMANITIES

1.	Bot.	91	Botany-I	3+1
2.	Bot.	92	Botany-II	3+1
3.	Eng.	91	English-I	2+1
4.	Eng.	92	English-II	2+1
5.	Pbi.	91	Punjabi-I	2+1
6.	Pbi.	92	Punjabi-II	2+1
7.	Zoo.	91	Zoology-I	3+1
8.	Zoo.	92	Zoology-II	3+1

20+8=28

COLLEGE OF AGRICULTUE

1.	Agron.	91	Agronomy-I	2+1
2.	Agron.	106	Water Management and MicroIrrigation	2+1
3.	Agromet.	102	Introductory Agrometerology	2+1
4.	Env.	91	Environment-I	3+0
5.	Ent./Pl.Path.	91	Plant Protection-I	2+1
6.	Ext.	91	Extension-I	2+0
7.	Hort.	91	Horticulture-I	2+1
8.	LPM	91	Animal Science-I	2+1
9.	Pl. Path.	101	Plant Pathogens and Principles of Plant Pathology	2+1
10.	Soils	91	Soils-I	2+1
11.	Soils	103	Introduction to Soil Science	2+1
12.	Veg.	101	Production Technology of Vegetables	2+1
13.	PFT	91	Practical Field Training-I	0+1
14.	PFT	92	Practical Field Training-II	0+1
15.	Ort.	91	Orientation	0+1(NC)

25+12=37+1(NC)

Total credit hours requirement for "2 Year Certificate Course in Agriculture"

65+ 1 (NC)

(Discounted w. e.f. academic session 2013-14)

COURSE CURRICULUM FOR ' 2 YEAR CERTIFICATE COURSE IN AGRICULTURE'

FIRST YEAR

SEM I			SEM II		
1. Agron.	91	2+1	1. Agron.	106	2+1
2. Bot.	91	3+1	2. Eng.	92	2+1
3. Soils	91	2+1	3. Agromet.	102	2+1
4. Eng.	91	2+1	4. Zoo.	91	3+1
5. Ort.	91	0+1(NC)	5. LPM	91	2+1
6. Pbi.	91	2+1			<u>11+5=16</u>
		<u>11+5=16+1(NC)</u>			

SECOND YEAR

SEM III			SEM II		
1. Env.	91	3+0	1. Bot.	92	3+1
2. Hort.	91	2+1	2. Soils	103	2+1
3. Veg.	101	2+1	3. Ext.	91	2+0
4. Ent./Pl. Path.	91	2+1	4. Zoo.	92	3+1
5.Pbi.	92	2+1	5. PFT	92	0+1
6.PFT	91	0+1	6. Pl.Path.	101	2+1
		<u>11+5=16</u>			<u>12+5=17</u>

(Discounted w. e.f. academic session 2013-14)