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DEPARTMENT OF BIOCHEMISTRY

Field of specialization : Plant and Animal Biochemistry, Food and Nutritional Biochemistry, Enzymology, Intermediary Metabolism and Molecular Biochemistry.

Required Courses :
M.Sc. : BIOCHEM-501, BIOCHEM-552, BIOCHEM-503, BIOCHEM-504, BIOCHEM-505, BIOCHEM-506, BIOCHEM-507/508, STAT-401 or STAT-408, GENET-501, MICRO-401
Ph.D. : BIOCHEM-601, BIOCHEM-602, BIOCHEM-603 and other required courses of M.Sc. (Biochemistry), if not already done.

Courses open to P.G. Students of other colleges/Departments for Minor Credits only - All post graduate courses (BIOCHEM-451 is Compulsory)

UNDERGRADUATE COURSES

BIOCHEM -151 ELEMENTARY PLANT BIOCHEMISTRY **2+1 SEM. II**
(For B.Sc. (Hons) Agril.)

Scope of biochemistry; Carbohydrates – function and classification, structure of biologically important monosaccharides, chiral carbon, stereoisomerism, optical activity and mutarotation, reactions of monosaccharides; structure and function of biologically important disaccharides, oligosaccharides, and polysaccharides; metabolism of carbohydrates – amylases, phosphorylase, glycolysis, TCA cycle and mitochondrial electron transport chain, HMP and glyoxylate pathways, gluconeogenesis; Lipids – classification and general functions, structure and properties of saturated, unsaturated and hydroxy fatty acids; triacylglycerols – physical and chemical properties, characterization of fats; structure and functions of waxes, phospholipids, glycolipids and fat soluble vitamins; metabolism of fats – reactions of β -oxidation and fatty acid biosynthesis; Proteins – general functions; classification, structure and reactions of amino acids, peptide bond, structural organization of proteins, metabolism of proteins – deamination, transamination and decarboxylation, urea cycle; Enzymes – classification, factors affecting enzyme activity, coenzymes, functions of water soluble vitamins; Nucleic acids – structure of nucleosides and nucleotides, RNA and DNA, functions of different RNA molecules, preliminary aspects of replication, transcription and translation; Photosynthesis – structure of chloroplasts, photosynthetic pigments, photosystems I and II, Calvin cycle and C_4 pathway; photorespiration; nitrogen metabolism – nitrogen cycle, symbiotic nitrogen fixation, nitrate and ammonia assimilation; plant hormones and their role.

Practical: Colour reactions of carbohydrates, proteins and amino acids; estimation of proteins, amino acids, carbohydrates, lipids and photosynthetic pigments; assay of enzymes.

BIOCHEM -152 INTRODUCTORY BIOCHEMISTRY **2+1 SEM. I**
(For B.Sc. Home Science)

Introduction to biochemistry – its importance and relationship to food and nutrition; Carbohydrates – definition, classification, general reactions, metabolism; Lipid metabolism – definition, classification digestion and absorption; saturated, unsaturated and essential fatty acids; oxidation, rancidity; Proteins – definition, classification, molecular weight, colloidal nature of proteins; amino acids – classification, chemical properties, amino acid metabolism, digestion and absorption, Protein quality estimation; Enzymes – chemical nature,

mechanism of enzyme action, specificity of enzymes, conditions for enzymes activities, coenzymes and prosthetic groups; Nucleic acids – RNA and DNA, their biological functions, structure and function of nucleosides and nucleotides; Vitamins – classification, structure and functions of vitamins; Hormones involved in regulation of metabolism; water balance, acid-base equilibrium.

Practical: Qualitative and quantitative tests for carbohydrates, lipids, proteins, amino acids and vitamin C; separation of amino acids by ascending and descending paper chromatography; determination of pH, use of pH meter; determination of starch, sugar; analysis of proximate constituents in food.

BIOCHEM-451 GENERAL BIOCHEMISTRY 3+0 SEM I/II

Cell, cell structure, subcellular organelles and biomolecules, structure and composition of biomembranes, transport across cell membranes; biological oxidation – reductions, bio-energetics and oxidative phosphorylation, enzymes, coenzymes and vitamins; metabolism of carbohydrates lipids, proteins and nucleic acids; nutritional aspects of carbohydrates, lipids, proteins and minerals; introduction to recombinant DNA technology.

BIOCHEM-453 FOOD CHEMISTRY 2+1 SEM. I

Chemistry of carbohydrates, fats, proteins and vitamins; chemical composition of foods; antinutrients; nutritive and supplementary value of different foods (plant, dairy, poultry etc.); biochemical aspects of post-harvest storage, preservation and processing; biochemistry of food spoilage and deterioration; enzymes in food industry.

Practical: Proximate analysis of foods (proteins, fats carbohydrates, ash, crude fibre, vitamins, minerals (Ca, P, Fe); analysis of major antinutrients; use of enzymes in food analysis.

POSTGRADUATE COURSES

BIOCHEM-501 STRUCTURE AND FUNCTION OF MAJOR BIOMOLECULES 3+0 SEM. I

Fundamental principles governing structure of biomolecules; hydrogen bonding, vander waals, electrostatic and hydrophobic interaction; biophysical techniques for structural determination and characterization of biopolymers (IR, NMR, X-ray diffraction, ESR, circular dichroism and ORD); structure, properties and functions of monosaccharides, storage and structural polysaccharides, glycoproteins, glycosaminoglycans, lectins, proteoglycans, amino acids, peptides, proteins – their structural organization, domains, Ramachandran plot, globular and fibrous proteins, immunoglobulins, lipids, lipoproteins, biomembranes, prostaglandins, prostacyclins, leukotrienes, vitamins; nucleotides, nucleic acids; structural polymorphism of DNA; structural determination of proteins, protein evolution.

BIOCHEM-502 INTERMEDIARY METABOLISM 3+0 SEM. II

Introduction to metabolism, methods of studying metabolism, bioenergetics, biological oxidation – reduction, energy transudation and oxidative phosphorylation; catabolic and anabolic pathways of carbohydrates, lipids, amino acids, proteins and nucleic acids and their metabolic disorders; cellular and organelle compartmentation of metabolic pathways, metabolic profiles of major organs and regulation of metabolic pathways.

BIOCHEM-503 ENZYMOLOGY 3+0 SEM. I

Enzyme nomenclature and classification; enzyme compartmentalization in cell organelles; isolation and purification of enzymes; measurement of enzyme activity; enzyme structure, cofactors, coenzymes – their structure and role, active site, enzyme specificity, mechanism of enzyme catalysis; enzyme kinetics, enzyme inhibition and activation; multienzyme complexes; ribozymes, isozymes, abzymes, allosteric enzymes and their kinetics; regulation of enzyme activity; active site mapping; enzyme immobilization, application of enzymes in chemical and food industry, biosensors and clinical application of enzymes.

BIOCHEM -504 MOLECULAR BIOCHEMISTRY

3+0 SEM. I

Nucleic acids as genetic material, structure and properties of nucleic acids; viral nucleic acids, lysogeny and lytic cycle in bacteriophages; genome organization; nucleases and DNA modifying enzymes; nucleic acid sequence determination; DNA replication; recombination, amplification and DNA rearrangements; carcinogenesis, mutagenesis and DNA repair; transcription and RNA processing; fine structure of gene, genetic code and protein biosynthesis; regulation of gene expression in pro- and eukaryotes; principles and methods of genetic engineering, cloning vectors, genomic and cDNA libraries, RFLP, PCR, gene targeting and gene therapy, applications of genetic engineering in agriculture, health and industry.

BIOCHEM -505 BIOCHEMICAL TECHNIQUES

0+3 SEM. I/II

Preparation of solutions and buffers; spectroscopy and fluorometry; quantitative estimation of carbohydrates, amino acids, proteins, lipids and vitamins in biological materials; separation techniques – centrifugation. Paper, thin layer and column chromatography, electrophoresis; isolation and assay of enzymes, simple enzyme kinetics; isolation and quantitative estimation of DNA and RNA; use of radioisotopes in metabolic studies.

BIOCHEM -506 IMMUNOBIOCHEMISTRY

3+1 SEM. I

Overview of immunology, antigens, haptens, adjuvants and antibodies, structure and function of immunoglobulin (Ig) molecules; Ig genes and antibody diversity; theories of antibody production; T-cell receptor structure and function; genes and T-cell repertoire; major histocompatibility complex (MHC) molecules and their genes; surface markers of lymphocytes and antigen presenting cells; cellular interactions in immune responses; kinetics of primary and secondary immune responses; cytokines, complement system and other effector molecules; antigen-antibody interactions; monoclonal and genetically engineered antibody molecules; recombinant DNA technology in immunology; molecular basis of defective immune response and immune system.

Practical: Production of antisera in laboratory animals; purification, quantitation and characterization of immunoglobulins; tests for antigen-antibody reactions such as agar gel precipitation, slide agglutination; haemagglutination, enzyme-linked immunosorbant assay, immunoblotting etc.

BIOCHEM -507 PLANT BIOCHEMISTRY

3+0 SEM. II

Scope and importance of biochemistry in plants; dark respiration, photosynthesis and photorespiration, regulation of carbon metabolism; nitrogen cycle, symbiotic and non-symbiotic nitrogen fixation, genetics and mechanism of nitrogen fixation, uptake hydrogenase; ammonia and sulfate assimilation, denitrification and chemoautotrophy; biosynthesis of carbohydrates, lipids and proteins, biochemical autonomy of chloroplasts; chemical composition and biosynthesis of plant cell wall; biosynthesis and role of secondary metabolites; plant hormones and their molecular mechanism of action, signal transduction mechanism in plants; toxic principles, pest and disease resistance.

BIOCHEM -508 ANIMAL BIOCHEMISTRY

3+0 SEM. II

Digestion and absorption of food; detoxification; biochemistry of specialized tissues – connective tissue, skin, muscle, nervous tissue and blood and other body fluids; water, electrolyte and acid-base balance; biochemistry of respiration; structure, function and mechanism of major trace elements, vitamins, hormones of thyroid, hypothalamus, pituitary, pancreas, adrenals and sex hormones, membrane receptors of hormones, biochemistry of reproduction; signal transduction.

BIOCHEM -509 FOOD AND NUTRITIONAL BIOCHEMISTRY

3+1 SEM. II

Physico-chemical, functional and nutritional characteristics of carbohydrates, proteins and fats and their interactions (emulsions, gelation, browning etc.); biochemical and nutritional aspects of vitamins, minerals, antinutritional factors; biochemistry of post harvest storage; effect of cooking, processing and preservation of different food products on nutrients; biochemical aspects of food spoilage, oxidative rancidity and anti oxidants. Enzymes in food industry, food additives (colouring agents, preservatives etc.); biogenesis of food flavours and aroma; nutritional quality of plant, dairy, poultry and marine products.

Practical: Determination of proximate composition of major nutrients in food (proteins, lipids, carbohydrates, minerals); determination of antinutritional factors such factors such as phytate, trypsin inhibitors in foods; *in vitro* digestibility of proteins and fractionation of storage proteins in cereals and legumes; determination of amino acid composition of food proteins.

BIOCHEM -601 ADVANCED ENZYMOLOGY

3+0 SEM. II.

Structure and conformation of enzymes; active centres of enzymes; mechanism of enzyme reactions, enzyme kinetics, allosteric enzymes their kinetics and role in regulation of metabolism; kinetics of multisubstrate reactions; kinetics of coupled enzyme systems; cytological aspects of enzymes.

BIOCHEM -602 ADVANCED MOLECULAR BIOCHEMISTRY

3+0 SEM. II

Organization of genome, nuclear and organelle genes, genome mapping; molecular evolution, cell development and differentiation; eukaryotic gene regulation; molecular biology of viruses, cancer and AIDS: *nif* genes; methods of gene isolation and transfer in plants and animals; molecular basis of male sterility; site directed mutagenesis, gene targeting and gene therapy; ethics and safety guidelines in recombinant DNA research.

BIOCHEM -603 SPECIAL TOPICS IN BIOCHEMISTRY

3+0 SEM. I

Advanced topics related to plant and animal biochemistry.

BIOCHEM -591 SEMINAR
BIOCHEM -600 MASTER'S RESEARCH
BIOCHEM -700 Ph.D. RESEARCH

1+0 SEM. I/II

DEPARTMENT OF BIOTECHNOLOGY AND MOLECULAR BIOLOGY

Field of Specialization for: Plant Biotechnology and Molecular
M.Sc. and Ph.D. Biology, Enzyme Technology,
Microbial Biotechnology

Required Courses

M.Sc. : BMB 501, 502, 503, 505, 506, 507,
Biochem 451,
Micro 401, Gen 501, Stat 408
Ph.D. : BMB 601, BMB 602/ 603/ 604 and required courses of M.Sc. if
not already cleared.

Courses open to M.Sc. : All postgraduate courses
Ph.D. students of other
colleges/ department for
minor

UNDERGRADUATE COURSES

BMB-201 INTRODUCTION PLANT BIOTECHNOLOGY 2+0 SEM. II

Scope of plant biotechnology; DNA structure and function; recombinant DNA techniques; gene isolation; gene transfer; plant tissue culture; principles and laboratory protocols; micropropagation; haploid production; somatic cell hybridization; transgenic plants; application of plant biotechnology in agriculture; biotechnology and society.

POSTGRADUATE COURSES

BMB-501/ PRINCIPLES OF BIOTECHNOLOGY 3+0 SEM. I
ABT 551

Scope of biotechnology; introduction of genetic engineering; plant and animal tissue culture; fermentation technology; immobilized enzymes; monoclonal antibodies and hybridoma technology; embryo transfer technology; application of biotechnology in agriculture; animal and veterinary sciences, pharmaceutical industry, food industry and chemical industry.

BMB-502/ MOLECULAR BIOLOGY-I 3+0 SEM. I
ABT 553

History of molecular biology; nucleic acids as hereditary material, structure of DNA; chromatin, rRNA, tRNA and mRNA; nucleases; nucleic acid sequencing; DNA replication; transcription, reverse transcriptase and RNA replicase; translation; genetic code; operon, positive and negative control of gene expression; attenuation; molecular mechanism of mutation.

BMB-503/ MOLECULAR BIOLOGY-II 2+1 SEM. II
ABT554

Molecular organization of cell; structure of genomes; synthetic chromosomes; replication, transcription and translation in eukaryotes; structure of primary transcript; ribozyme, RNA processing and alternate splicing; molecular biology of photosynthesis; nitrogen fixation and stress tolerance; development and differentiation; molecular evolution.

Practical: Estimation of proteins; RNA and DNA; SDS-PAGE of proteins; DNA isolation, purification and characterization; DNA/RNA/protein blotting; polymerase chain reaction; DNA restriction analysis; RFLP and RAPD analysis.

BMB-504/ PRINCIPLES OF IMMUNOLOGY 2+1 SEM. I

ABT 552/
VIM-551

(Basic course for all Immunology courses)

History of immunology; antigens, adjuvants, immune system; organs, tissues and cells; immunoglobulins, monoclonal antibodies; recombinant antibodies; theories of generation of antibody diversity; complement systems, classical and alternate; cellular interaction in the immune response; major histocompatibility complex; cell mediated immune response, cytokines, immunoregulation; immunological tolerance, hypersensitivity; mechanisms of immunity; innate resistance and specific immunity.

Practical: Handling, inoculation and bleeding of laboratory animals; preparation of antigens and antisera; natural antibodies; carbon clearance test, lymphoid organs of the mouse; morphology of the blood leucocytes; separation of lymphocytes from blood; viable lymphocyte count, antigen-antibody interaction; precipitation, immunoelectrophoresis, agglutination direct and indirect haemagglutination; complement fixation; quantitation of immunoglobulins by zinc sulphate turbidity and single radial immunodiffusion.

**BMB-505/
ABT 556**

GENETIC ENGINEERING

3+0 SEM.II

Enzymes used in recombinant DNA research; vectors for cloning DNA; gene identification; isolation and development of gene libraries; molecular cloning; gene mapping and DNA structure analysis; sequencing and synthesis of double stranded DNA and complementary DNA; cDNA libraries; identification and enrichment of recombinant clones; methods for transfer of cloned DNA; analysis of expression of recombinant DNA; site directed DNA alterations and gene manipulations; cloning in bacteria other than *E. coli*; cloning in yeast; cloning vectors for genes of plant cells; genetics of tumourigenic DNA region of *agrobacteria* and its exploitation; applications for general improvement of plants; animals and human beings and their protection against diseases; biotechnological applications for production of high value and industrial products; safety aspects of gene manipulation.

BMB-506

TECHNIQUES IN BIOTECHNOLOGY

0+3 SEM. I

Isolation of plasmid and chromosomal DNA from bacteria; yeast and plants; restriction analysis of nucleic acids; nick translation; southern hybridization; *in vitro* DNA ligation; cloning in *E. coli* and cultured plant cells; nucleic acid sequence determination; site directed mutagenesis.

BMB-507

PLANT CELL AND TISSUE CULTURE

2+1 SEM. II

History and scope, totipotency and cell theory; principles underlying *in vitro* culture; growth and differentiation; culture media and its constituents; micropropagation; bioreactors; synthetic seeds; meristem tip culture; somaclonal variation; anther and microspore culture; *in vitro* mutagenesis; production of secondary metabolites; ovary, ovule and embryo culture; endosperm culture; protoplast culture and somatic cell hybridization; gene transfer methods; transgenic plants; cryopreservation and germplasm conservation.

Practical: Plant tissue culture research facilities; preparation of nutrient media; handling and sterilization of plant material; isolation, inoculation and subculturing; establishment of cell suspension cultures; protoplast isolation and culture; plant regeneration; demonstration of gene transfer experiments.

**BMB-508/
MICRO-505**

MICROBIAL BIOTECHNOLOGY

2+1 SEM. II

Introduction, scope and historical development; isolation screening and genetic

improvement of industrially important microorganisms; type of fermentation systems; production of various primary and secondary metabolites, e.g. amino acids, organic acids, alcohols, enzymes, organic solvents, antibiotics, etc.; down stream processing; over production of metabolites; bio-reactor operations, process control; fermented beverages; production of single cell protein; steroid transformation; immobilization of cells/enzymes; silage production; waste water treatment; use of genetically engineered microorganisms in biotechnology; bioinsecticides, biofertilizers, etc.; food colours and flavours; retting of flax.

Practical: Isolation of industrially important microorganisms, their maintenance and improvement; production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery; study of bio-reactors and their operation; production of biofertilizers.

BMB-509/ ANIMAL CELL AND TISSUE CULTURE 1+2 SEM. II
ABT 558/VMI-562/
VMC 563

Development of tissue culture technique; behaviour of cells in terms of growth, differentiation and metabolism; media for culturing cells and tissues, natural and defined media and growth supplement; culture of different tissues and its applications; characterization and maintenance of cell lines, cryo-preservations.

Practical: Nutritional needs of mammalian cells in tissue culture; short term lymphocyte culture, fibroblast culture; cell hybridization; micro manipulation.

BMB-510/ BIOTECHNOLOGY-ENVIRONMENT AND SOCIETY 2+0 SEM. II
ABT 564

Environmental impact of industrial effluents; biosensors; renewable sources of energy; history of biotechnology regulations; guidelines for research involving genetically modified organisms (GMOs); ecological considerations and recommendations for planned release of GMOs; biodiversity gene banks; intellectual property rights (IPR); GATT; TRIPS; farmer's rights; ethical and socio-economical issues.

BMB-511/ BIOINFORMATICS 2+1 SEM. II
ABT 562

Overview & Scope; Introduction to Database System:- Relation and distributed database system; SQL and reports; Multimedia database; Biological Databanks and Analysis:- Data-warehousing; Capture and Analysis; Sequence Database; Gene Bank; EMBL nucleoside sequence database; Pairwise alignment; PDB and CSD; Prediction of RNA secondary & higher level structures; Design of PCR primers & ePCR; Computer Networking:- Basic concepts; LAN, WAN, WWW, Ethernet, TCP/IP, Client source concept; Biomolecular Structure and Dynamics:- Co-ordinate system; Energy calculation; 3D structure of Biomolecular mechanics and Dynamics; Protein-drug interactions; HTML programming language:- Techniques; Software and hardware; 3D image construction; Rendering and Animation; Automation for Biologists.

Practical: Use of INTERNET & WWW, Searches on MEDLINE, CD-ROM bibliographic databases. RASMOL, MOLMOL, MX, VRML etc. Use of Molecular Model Packages. Programs to calculate potential energy of regular structures. Analysis of Protein and Nucleic acids sequences.

BMB-601 ADVANCES IN MOLECULAR BIOLOGY 3+0 SEM. II

Genome organization in prokaryotes and eukaryotes; post-transcriptional and translational events; DNA-protein interactions; advances in protein engineering;

technological applications of molecular biology; molecular biology of specialised tissues, cells and cell organelles; molecular mechanism of regulation and differentiation; current topics of molecular biology.

BMB-602 ADVANCED PLANT GENETIC ENGINEERING 3+0 SEM I

Plant genetic engineering and conventional plant breeding; current techniques of identification and isolation of plant genes; plant gene sequences; recent gene transfer strategies for crop improvement; development of transgenic plant; expression of transgenes; metabolic engineering and molecular farming; recent advances in genetic transformation; ethics and safety guidelines.

BMB--603 CURRENT TOPICS IN MICROBIAL BIOTECHNOLOGY 3+0 SEM. I

Fermentative metabolism and genetic improvement of industrially important microorganisms through recombinant DNA technology; current advances in production of antibiotics, vaccines, biocides and steroid transformation; bioreactors; bioprocess engineering; products of non-microbial origin produced by genetically engineered microorganisms.

**BMB-604/
PB 604 BIOTECHNOLOGY FOR CROP IMPROVEMENT 2+1 SEM II**
(Pre-requisite BMB 501/PB 504)

Recombinant DNA technology, transgenes , method of gene transformations, vector-mediated gene transfer, physical methods of gene transfer, production of transgenic plants in various field crops; cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. GMOs related issues (risk and bio safety regulations). Biotechnology applications in male sterility/hybrid breeding, molecular farming. Molecular breeding: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR etc.), mapping populations (F2s, back crosses, RILs NILs and DH). Molecular mapping and tagging of agronomically important traits, QTLs analysis in crop plants, Marker-assisted selection for qualitative and quantitative traits, Gene pyramiding.

Practical: Transformation using *Agrobacterium* strains, GUS assay in transformed cells/tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

BMB-591 SEMINAR 1+0 SEM. I & II
BMB-600 MASTER'S RESEARCH
BMB-700 Ph.D. RESEARCH

DEPARTMENT OF BOTANY & PLANT PHYSIOLOGY

BOTANY

Field of specialization for M.Sc. and Ph.D.

Botany: Reproductive Biology, Ecology, Morphogenesis
And Plant Tissue Culture

Plant Physiology : Growth and Development, Stress Physiology,
Nodulation and Growth Regulators

Required Courses :

Botany M.Sc. : Bot. 501 to Bot. 507

Ph.D : Bot. 601 to 603

Plant Physiology

M.Sc. : P. Phy. 501 to P. Phy. 506, Biochem. 451 and Stat. 401

Ph.D. : P. Phy. 602, P. Phy. 604, Biochem. 503 and Stat. 402

UNDERGRADUATE COURSES

BOT. 103 ELEMENTARY BOTANY 2+1 Sem. I

(Deficiency course for Non-Medical students)

Basic features and principles of nomenclature; salient features of Monerans – Bacteria, Fungi-Rhizopus; Protists and Plantae – *Ulothrix*, *Marchantia*, *Selaginella*, *Pinus* (no structural detail). Morphological features of flowering plants – structure of flower, pollination, fertilization, structure and germination of seeds. Tissue and tissue systems. Absorption and movement of water, mineral and nitrogen nutrition, photosynthesis, respiration, growth and development of plants. Environmental pollution, its impact and method of control.

Practical: Study of specimens and slides pertaining to the above topics.

BOT. 401 INTRODUCTORY BOTANY 2+1 Sem. I (Elective for Biosciences)

Concept of classification and nomenclature, diagnostic features and economic importance of Ranunculaceae, Leguminosae, Cucurbitaceae, Compositae and Graminae. Study of anatomical features of root, stem and leaf, ecological anatomy of a typical hydrophyte and xerophyte. Structure and development of anther, male gametophyte, ovule, female gametophyte, pollination, fertilization, endosperm and embryo. Seed physiology, absorption and movement of water, mineral nutrition, uptake, transport and roles of nutrients, photosynthesis, respiration, growth and development. Environmental pollution.

Practical: Study of representative genera of different families. Examination and preparation of permanent slides of histological material. Demonstration of experiments on above related topics.

POSTGRADUATE COURSES

BOT. 501 ALGAE 2+1 Sem. I

Major groups of algae and their characters, Classification, thallus organisation, reproduction and life history; algal associations, phylogeny and evolutionary relationship and economic importance.

Practical: Examination of representative genera of algae to study their morphology and reproductive structures, field collection and observation.

BOT. 502 ARCHEGONIATE 2+1 Sem. I

Introduction to plant diversity in bryophytes, pteridophytes and gymnosperms and their origin, classification, comparative morphology and reproduction of important

mastigatories, tobacco, betel-vine, arecanut, insecticides, neem, lemongrass, nontraditional economic plants; jojoba, guayule, utilization of crops residues; cotton stalks, paddy husk, coconut fibres.

Practical: Study of plant specimens of economic importance and their acquaintance with their products. Exploration, collection and preservation of economically important plants and their products.

BOT. 601. REPRODUCTIVE BIOLOGY OF ANGIOSPERMS 2+1 Sem. II

Development and ultrastructure of anther, pollen, ovule, embryo sac. Biochemical constituents of pollen and their significance. Concept, composition and significance of male and female germ unit, pollination biology, pollen-pistil interaction and fertilization; self-incompatibility methods and mechanism of overcoming interspecific crossing barriers. Developmental details and morphogenesis of endosperm, embryo, fruit and seed. Isolation and manipulation of sperm cells and embryo sac, physiology and biochemistry of generative cells and male gametes. Plant transformation through sexual structures.

Practical: Developmental studies of pollen, embryo sac, embryo, fruit and seed of selected crop plants through dissection, microtomy, clearing technique and histochemical tests.

BOT. 602 APPLIED EMBRYOLOGY AND TISSUE CULTURE 3+1 Sem.

Pollen collection, preservation, viability and their nutritional requirements; male sterility, pollen allergens, concept of pollen selection and its significance in crop improvement programme; artificial pollination and its role in crop improvement. Plant reproduction under environmental stresses. Recent advances in *in vitro* culture of anther, embryo and endosperm, pollen embryos, morphogenesis of embryo and endosperm, pollen embryos, morphogenesis of embryoids and plants, concept of somatic embryogenesis; protoplast culture, induction of somaclonal variation and its practical utility. *In vitro* methods as applicable to agricultural crops, forestry trees and medicinal plants. Topics of current interest.

Practical: Studies of different methods of pollen collection and preservation, culturing of anthers, pollen and young embryos using various culturing media and study of differentiation and development.

BOT. 603 CONTEMPORARY PLANT ANATOMY 2+1 Sem. I/ II

Ultrastructure in relation to growth and differentiation in plants, detailed study of development and factors controlling the development of cells, tissue and organs, experimental studies and differentiation of meristems, control of differentiation and experimental investigation of xylem, phloem, secretory structure, economic importance of plant secretions, wound healing and behaviour of tissues in compatible and incompatible graft unions, environmental and nutritional factors in relation to structure and development of plants, organs and tissue; developmental anatomy of fruits and seeds.

Practical: Study of structure of cell wall and anatomy of various plant organs through histochemical methods and through clearing, maceration and microtome preparation.

BOT. 604 ADVANCED PLANT ECOLOGY 2+1 Sem. I/ II

Principles of ecosystem, energy dynamics, stability, limiting factors and plant community, environmental factors in relation to plant growth, competition, factors in arid and semiarid regions of India, system analysis, world biota, floristic

and stress responsive proteins. Screening for drought resistance – empirical and analytical techniques, approaches to breeding drought resistance. Waterlogging / Oxygen deficiency and its effects on plant growth. Salt stress: Saline and alkaline soils, salt stress injury, mechanism of salt tolerance and halophytes. Temperature stress: High temperature stress, heat shock proteins, chilling and frost injury, and mechanism of tolerance. Light stress: high and low light stresses, UV-B effect on plant growth and development. Pollutant and heavy metal stress: chemical, air and gaseous pollutants and their effect on plant growth, green house gases and global warming. Effect of heavy metals on plant growth and development.

Practical: Determination of water status of plant tissues and organs by measuring water potential and its components and relative water content. Experiments on stomatal physiology and transpiration. Demonstration of plants responses to stresses through recent techniques.

P. Phy. 502 PHOTOSYNTHESIS, AND NITROGEN FIXATION 3+1 Sem. I
RESPIRATION

Chloroplast structure. Photosystems – their structure and function. Chlorophylls and other pigments. Mechanisms of light absorption, redox reactions, photosynthetic electron transport chain, photophosphorylation and quantum yield concept. Carbon metabolism: C₃, C₄ and CAM pathways and their distinguishing features. Photorespiration and its significance. Chloroplast genome and its expression, interaction of chloroplast and nuclear genes. Synthesis of sucrose and starch, mechanism of their translocation, phloem loading and unloading. Translocation of photosynthates, mechanism and significance. Source sink relationships, partitioning and harvest index. Pathways of glucose oxidation in plants. Mitochondrial electron transport chain and its role. Cyanide resistant respiration pathway. Importance of mitochondrial genome. Factors affecting respiration rate. Growth and maintenance respiration and its significance in crop improvement. Dinitrogen fixation by symbiotic and free-living organisms: infection process, nodule development, structure and senescence. Biochemical process of nitrogen fixation, nitrogenase enzyme complex, uptake hydrogenase, leghaemoglobin. Genes involved in symbiotic nitrogen fixation.

Practical: Isolation and characterization of photosynthetic pigments, various methods of estimating photosynthesis, respiration, nitrogen fixation.

P. Phy. 503 INORGANIC NUTRITION 2+1 Sem. II

Mineral nutrients and their classification. Soil and plant factors affecting mineral availability. Mechanism of uptake and translocation of ions electrochemical potential, active and passive absorption, ion transport in soil plant continuum and driving forces involved, ionic mobility in plant tissues and organs, intracellular ionic compartmentation. Role of essential elements. Diagnosis of nutrient disorders by visual symptoms. Chemical fertilizers and organic farming. Genetics of plant nutrition. Nutrient mobilization by mycorrhizae. Nutrient use efficiency. Metabolism of nitrate, sulphate and phosphate – its uptake, reduction and assimilation.

Practical: Plant tissue analysis, estimation and localization of mineral elements. Foliar nutrition and hydroponics.

P. Phy. 504 DEVELOPMENTAL PHYSIOLOGY 3+1 Sem. II

Practical: Study of physiological and biochemical changes during natural and induced senescence and abscission, hormonal regulation of these processes.

**P. Phy. 508/
Bot. 508**

LABORATORY METHODS IN PLANT PHYSIOLOGY 0+2 Sem. II

Microtechnique for histological and histochemical studies; manometric techniques, electrophoresis; chromatography; spectrophotometric techniques and infrared gas analysis. Measurement of water potential and its components, stomatal conductance.

**P.Phy. 509/
ST. 506**

SEED PHYSIOLOGY

2+1 Sem. I

Characteristics, structure and chemical composition of seed. Seed developmental patterns and source of assimilates for seed development; pathway of movement of assimilates in developing seeds of monocots and dicots; synthesis and accumulation of food reserve. Seed maturation; desiccation damage; role of LEA proteins. Seed dormancy—types, mechanism, endogenous and exogenous factors affecting dormancy, role of phytochrome. Seed viability and longevity, pre and post harvest factors affecting seed viability, loss of viability, physiology of seed ageing and viability theories; means to prolong seed viability. Seed vigour and its concept, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield. Seed germination; factors affecting germination; physiological processes during seed germination; seed respiration, mobilization of stored resource in seeds; oxidation of starch, proteins and fats; utilization of breakdown products by embryonic axis; role of embryonic axis; gibberellin and α -amylase and other hydrolytic activity. Effect of age, size and position of seed on germination.

Practical: Proximate analysis of chemical composition of seed. Methods of testing viability, germination and breaking dormancy of seeds; pre-soaking treatments for improving germination; physiological and biochemical changes during germination.

P. Phy. 510

**CROP PRODUCTIVITY AND
MODELLING**

2+1 Sem. II

Crop growth analysis, key growth parameters, canopy architecture, light interception and concept of source-sink relationships. Allometric growth relationships, partitioning efficiency and harvest index. Plant growth analysis techniques, yield analysis, theoretical and actual yields. Physiology of major field crops. Plant ideotypes. Crop growth models – empirical models testing and yield prediction.

Practical: Computer applications in plant physiology, crop productivity and modelling.

P. Phy. 601

**ADVANCED NUTRITION AND
METABOLISM**

3+0 Sem. I

Ionic relation of cells, tissues, organs and whole plant; transport systems: ion transport and metabolism, regulation of transport, symplastic movement and apoplastic movement. Salt relation of specialized plants like halophytes, patterns of redistribution of ions, salt relations and growth, cell models of transport physiology, correlations between the fine structure of cytoplasm and transport functions. Regulation and control of transport processes by cell metabolism, medium distance and long distance transport, nitrogen productivity concept.

P. Phy. 602	ADVANCED STRESS PHYSIOLOGY	3+0	Sem. I
	Advance account of molecular and metabolic responses to various stresses, water, salt, temperature, air pollution, heavy metals and radiation, mechanisms of their injury and resistance; osmoregulation, mechanisms of stomatal movement. Residual effect of pesticides. Interactive responses to multiple stresses.		
P. Phy. 603	PHYSIOLOGY OF FLOWERING	3+0	Sem. II
	Flowering, light and temperature control; induction, threshold, persistence, perpetuation and reversion. Florigen – anthesin concept and characterization. Floral inhibitors and fractional induction. Importance of light and dark period in relation to temperature and fractional induction, role of phytochrome and circadian rhythms; hormonal control. Biochemical and molecular aspects of floral induction and expression, sex expression, physiology and control.		
P. Phy. 604	MECHANISM OF PLANT HORMONE ACTION	3+0	Sem. II
	Hormone perception and signal transduction; nature of hormone receptors, hormonal regulation of gene expression; calcium and hormone action. Oligosaccharins, brassinolides, polyamines and other molecules having hormone-like activities; jasmonates – nontraditional regulators of plant growth, development and gene expression. Role of plant hormone sink plant defense mechanisms.		
P. Phy. 605/ ST. 602	ADVANCE SEED METABOLISM	3+0	Sem. II
	Advanced account of the physiology of seed viability and deterioration, molecular, metabolic and hormonal aspect of seed viability, seed germination and seedling vigour.		
P. Phy. 591 P. Phy. 600 P. Phy.700	SEMINAR MASTER'S RESEARCH Ph.D. RESEARCH	1+0	Sem. I/ II

DEPARTMENT OF CHEMISTRY AND PHYSICS

Field of specialisation for : Inorganic, Organic, Physical, Bioinorganic and
M.Sc. & Ph.D. Pesticide Chemistry.

Required Courses M.Sc (Chemistry): CHEM. 502, CHEM. 503, CHEM. 511,
CHEM. 513, CHEM. 521, CHEM. 523, CHEM. 591.
Ph.D (Chemistry): CHEM. 601, CHEM. 602 OR CHEM. 611,
CHEM. 612 OR CHEM. 621 OR
CHEM. 621, CHEM. 622 and CHEM. 591.

Courses open to M.Sc : All Postgraduate courses

Students of other Colleges/

Departments for minor credits only.

CHEM .401/411/421 are required courses for all 500 and 600 series courses for the respective disciplines.

UNDERGRADUATE COURSES

Chem-1 General Chemistry (For H.Sc) 2+1 Sem-I

Atoms, Molecules, Mole concept, States of Matter, Atomic Structure, Periodic classification of elements, Chemical bonding, Chemical equilibrium, Energetics, Electro Chemistry, Chemical kinetics, Surface chemistry. Transition metals co-ordination compounds.

Chem-2 Introductory Organic Chemistry (for H.Sc.) 2+1 Sem-II

Basic concepts of organic chemistry, Classification and nomenclature of organic compounds, Isomerism-structural and stereoisomerism, petroleum-sources of organic compounds. Some important methods of preparation and properties of methane/ethane, ethylene, acetylene, benzene, ethylchloride, ethylalcohol, phenol, diethyether, acetaldehyde, benzaldehyde, acetone, acetic acid, benzoic acid, ethylamine, nitrobenzene, aniline. Introduction of biomolecules- glucose, fructose, sucrose, lipids, proteins and amino acids. Vitamins, Dyes, Drugs and Propellents.

Practicals: Detections of elements(N,S,X) and functional groups, any two preparations(iodoform, aspirin, orange dye preparations of any two house hold items for daily use such as, Talecom face powder, vainshing/cold cream, soap, silver mirror, nail polish, removal of colour stains from clothes.

Chem-101 Chemistry (For B.Tech. Agril Engg.) 3+1 Sem-I

Water Hardness-determination of hardness by EDTA method, degree of hardness, chloride, dissolved oxygen, dissolved carbondioxide and sulphate, colorimetric method for the determination of pH, control of pH of water used in industry. Chemical Fuels-classification of fuels, solid fuels, coal origin and its classification, proximate and ultimate analysis of coal; significance of constituents, gross and net calorific values; determination of calorific value by Bomb Calorimeter. Liquid Fuels-advantages, petroleum-origin, classification, refining of petrol; gasoline, knocking, octane number, chemical structure and knocking anti knock agents, cracking. Gaseous Fuels-advantages, manufacture, composition and calorific value of coal gas and oil gas, determination of calorific value of gas by Junker's calorimeter. Flue gas analysis by Orsat apparatus, calculations based on combustion. Corrosion-definition and its significance, theories of corrosion. Galvanic cell and concentration cell, pitting and stress corrosion; protection of corrosion; use of inhibitors and passivation; alloying protective coating, metallic, inorganic and organic. Cement-manufacture of

complexes: Basic concepts and their applications to complexes of tetrahedral and octahedral geometry. Complexes containing metal-carbon bonds. Wetting agents, cross-linking agents, finishing and printing agents. Soaps and detergents: General properties and analysis.

Chem-423 CHEMISTRY OF CLOTHING MATERIALS (For H.Sc) 2+2 Sem-II

Classification and chemistry of dyes and their intermediates, colour and chemical constitution. Chemistry and application of dyes for man made and natural fibres. Theory of dyeing, photochemistry of dyes. Optical brightening agents. Chemistry of pigments. Mechanism of dyeing on specified fibres. Practicals: Identification of intermediates and derivatives used in dyes. Preparation and isolation of dyes. Determination of copper number, methylene number and carboxylic group in degraded cellulose.

Phy-I Introductory Physics-I (For H.Sc) 2+1 Sem I (2nd Yr)

Units, dimensions and measurements, order of magnitude, Accuracy and errors in measurement, significant figures and rounding off. Motion in one dimension, equations of motion position time graph, velocity time graphs and relative velocity, motion in two and three dimensions, composition and resolutions of vectors, Uniform circular motion. Force and inertia, first law of motion, momentum, second law of motion, impulse third law of motion and friction. Work done by a variable force, units, kinetics and potential energies, conservation of energy, elastic collision in one dimension, mass energy equivalence and law of conservation of energy. Gravity, gravitation, Newton's of gravitation, variation of g with altitude, depth and rotation of earth. Properties of solids liquids of gases, pascal's law and home water supply. Fundamentals of heat flow and measurement of temperature. Freezing mixtures, refrigerators, Hygrometry, Air Conditioning, solar cooker.

Practicals: Use of vernier calliper, screw gauge and spherometer, 'g' by simple pendulum, weight of a body by parallel-gram law, volume of a solid by Archimede's principle.

Phy-2 Introductory Phy-II (for H.sc) 1+1 Sem-II

Reflection of light, refraction of light, dispersion, spectrometer, colour of bodies optical instruments: Microscope, telescope, Eye, photographic Camera and Projectors. Electric current and resistance, heating effect of current. Thermoelectric effect of current, chemical effect of current. Magnetic effect of current, electromagnetic induction.

Generators motors, Transformer, House Hold wiring. Fuses, Heaters, Geysers, Vacuum cleaner. Gas and electrical meters, centrifuge, washing machine and thermostats. Satellites and their applications.

Practical: Refraction through slab, Refraction through prism, focal length of concave mirror and convex lens, Ohm's law.

Phy-101 PHYSICS (For B.Tech.Agril Engineering) 3+1 Sem-I

Optics-interference, thin films-testing of the optical planeness of surfaces. Young's double slit experiment –coherent sources lasers, intensity young's experiment, interference in thin films. Newton's ring and Michelson interferometer: Diffraction-Fraunhofer-diffraction at single slit, diffraction at a circular aperture, diffraction at double slit, diffraction gratings, resolving and dispersive power of a grating: Polarisation-production and detection of circularly and elliptically polarised light. Quarter and half wave plates, optical activity, specific rotation. Lontenz half shade polarimeter. Determination of specific rotation and strength of sugar solution; Lasers-coherence temporal and sparial, Einstien's coefficient, spontaneous and stimulated emission. Population

inversion, laser gain, (pumping) spectral narrowing in lasers coherence length different types of laser source and their applications; Crystal structure- Seven systems of crystals. Bravais space lattice, crystal structure (bcc, fcc and sc), lattice dimensions, lattice planes and Miller indices and their significance, x-rays- absorption of x-rays, diffraction- Bragg's law. Bragg's x-rays. Spectrometer. Nuclear radiations- interaction of nuclear radiation with matter scattering of charged particles from nucleus, detection of radiation using G.M counter and scintillation counter. radiation hazards, dosimetry: Quantum theory- wave particle duality, uncertainty principle. Schrodinger equation and its application to particle in a box and harmonic oscillator: Ultrasonic production, application in ranging, cleaning and drilling: production and measurement of vacuum. Mechanical pumps (rotary vacuum pump), diffusion and condensation pumps. (Leak test and measurement: Manometer, McLeod gauge, Pirani gauge. Practicals: Surface tension by capillary and Jaeger methods: Viscosity by Stoke's Law, Thermal conductivity by Searl's method, Mechanical equivalent of heat by Callender and Baer's method, Frequency of A.C mains, low resistance by Carey Foster bridge, characteristics of semi-conductor junction and transistors.

POSTGRADUATE COURSES.

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|-----------------|--|------------|---------------|
| Chem-501 | QUANTUM CHEMISTRY-STATISTICAL MECHANICS | 3+0 | Sem-I |
| | Historical background and the postulates of quantum mechanics; mathematical consideration and solution of hydrogen; atomic structure approximate methods and atomic spectra; Boltzmann distribution function; general relationships- translational, rotational and vibrational motions, equilibrium constants; application of partition functions; Bose-Einstein statistics and Fermi-Dirac statistics, application to radiation and electron gas in metals. | | |
| Chem-502 | THERMODYNAMICS | 3+0 | Sem-II |
| | Brief resume of the concepts of free energy, entropy and laws of thermodynamics, partial molar properties; thermodynamics of ideal and real gases and gas mixtures; thermodynamics of ideal and non-ideal binary solutions; activities and activity coefficients of electrolytes; derivation of phase rule and its application to multi-component systems; non-equilibrium thermodynamics- entropy production in irreversible process. Phenomenological equations, membrane permeability, membrane transport involving biochemical reactions, phenomenological equation in non-linear regions, thermodynamics of living systems, metabolic and biosynthetic reactions, ATP production during biochemical process of various types, applications of irreversible thermodynamics in biological processes. | | |
| Chem-503 | CHEMICAL KINETICS AND SURFACE CHEMISTRY | 2+1 | Sem-I |
| | Theories of reaction rates, collisions theory, transition state theory, theory of unimolecular reactions- Lindemann's mechanism; rate constants of fast reactions- relaxations, stop-flow and flash photolysis techniques, mechanism of free radical reactions, hydrogen-bromine reaction, photochemical decomposition, polymerisation, explosion, ionic reactions: complex reactions- electron transfer reactions, consecutive, opposing reactions; kinetics of catalytic reactions, acid base catalysis, effect of pH and salt effects, enzyme catalysis: adsorption- types of adsorption Freundlich's adsorption isotherm, Langmuir's adsorption isotherm and its limitations, B.E.T adsorption isotherm; chemisorption, kinetics of surface reaction and their mechanism. Practical: Chemical kinetics- kinetics of catalytic reactions, distribution law, viscosity, phase rule and partial molar volume. | | |

Chem-504	SPECTROSCOPY	2+1	Sem-I
	<p>Molecular structure-molecular orbital methods for H_2^+ and H_2 molecule; the valence bond description of H_2; electron spin functions; correlation diagram for diatomic molecules; Huckel method for calculating resonance energy; rotation and vibration of molecules-linear and non-linear molecules, derivations of energy levels, selection rules; rotational vibrational spectroscopy-rotational and vibrational level corrections; electron spectroscopy; Raman Spectroscopy; Nuclear Magnetic Resonance Spectroscopy; Laser spectroscopy. Practical: Applications of spectroscopy for structural studies.</p>		
Chem-505	EXPERIMENTS IN PHYSICAL CHEMISTRY	0+2	Sem-I
	<p>Conductivity; potentiometry; pH metry; polarography; amperometric titration, spectrophotometry; flame-photometry; refractometry; cryoscopic and ebullioscopic measurements; chromatography.</p>		
Chem-506	BIOPHYSICAL CHEMISTRY	3+0	Sem-II
	<p>Structure and functions of biomolecules in living systems; statistical mechanics of biopolymers; statistical distribution and calculation of average dimensions; multiple equilibria and various types of binding processes in biological systems; thermodynamics of biopolymer solutions; structure and function of cell membrane; irreversible thermodynamics-treatment of membrane transport; enzyme kinetics and enzyme inhibitory reactions, evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various physical techniques.</p>		
Chem-507	GENERAL PHYSICAL AND COLLOID CHEMISTRY (for H. sc)	3+0	Sem-II
	<p>Thermochemistry: Heat changes at constant pressure and constant volume. Thermochemical laws, and Kirchoff's equation. Chemical Equilibrium: Introduction, chemical equilibrium constant, thermodynamic derivation of law of chemical equilibrium. Vant Hoff equation. Experimental methods. Catalysis. kinetics: First and second order reactions. Electrochemistry: phenomena of electrolysis, Faraday's Laws of electrolysis, conductance of electrolytes. Theory of electrolytes, migration of ions, transport number. Simple treatment of e.m.f of cell. Pits measurement by indicatory and electrometric methods. Control and utility of pH in textile wet processing. Electrochemical theory of corrosion. Colloid Chemistry: Theoretical properties of colloidal systems, intrerfacial phenomena, practice kinetics, electrical properties, viscosity. Lyophobic and lyophilic solutions, gels and emulsions developed from above properties.</p>		
Chem-508	CHEMISTRY OF POLYMERS (for H.sc)	3+0	Sem-I
	<p>Classification of polymers, molecular weights, physical properties of polymers, mechanism of polymerisation, chemistry of some industrially important polymers. Epoxy and phenolic resins. Copolymerisation. Techniques of polymerisation. Application of polymers to textiles. Essential properties of fibre forming polymers. Structure and degradation products of cellulose and their determination.</p>		
Chem-511	BASIC CONCEPTS OF INORGANIC CHEMISTRY	3+0	Sem. I
	<p>Review of the atomic structure-wave mechanical approach, wave functions for hydrogen atom, radial distribution curves for s, p, d and f orbitals, angular wave</p>		

functions for s, p, d and f orbitals-their significance and use; Slater-type orbitals; effective nuclear charge; use of radial distribution curves to explain order of filling of orbitals in many electron system; review of chemical bond; application of VB, MO and VSEPR theories in explaining the structure of simple molecules, rules for classification of molecules into point groups, group multiplication tables, degenerate and non-degenerate point groups, rules for fundamental vibrations; inorganic free radicals-their general reactions, preparation and uses; measurement of free radical concentration and decomposition rate.

Chem-512 CHEMISTRY OF TRANSITION METALS 2+1 Sem II

Transition elements-Hund's rule and spectroscopic energy states; magnetism in transition meta chemistry origin and nature of paramagnetism, diamagnetism, ferromagnetism and anti-ferro-magnetism; magnetic susceptibility and magnetic moment calculations, elements of 2nd and 3rd row transition series; chemistry of iso- and heteropolyacids and anions of Mo and W; the metal -metal bonds, general remarks on compounds with two centered metal meta bonds; metal clusters, occurrence, electronic structure, oxidation states, stereo chemistry, magnetic and spectral properties of lanthanide's and actinides; lanthanides contraction, separation of lanthanides and actinides; chemistry of rare elements francium, technitium, rehenium.

Practical: potentiometric determination of formation constants of 3d-series transition metal ions.

**Chem-513 COORDINATION CHEMISTRY, REACTION MECHANISM 3+0 SEM. I
AND INORGANIC POLYMERS**

The theories of bonding in coordination compounds -valence bond theory, electroneutrality principle and back-bonding, crystal field theory and its application for understanding magnetic and spectral properties of metal complexes, structural effects of crystal field splitting (ionic radii, Jahn-Teller effect), thermodynamical effects of crystal field splitting (hydration, ligation and lattice energies). Limitations of crystal field theory; adjusted crystal field theory (ligand field theory); application of molecular orbital theory of square planar, tetrahedral and octahedral complexes; stability of complexes-methods of determination, factors influencing stability; substitution reactions in octahedral complexes and associated stereochemical changes, redox reactions in coordination compounds and their mechanism; transition metal complexes of pi acceptor ligands; inorganic polymers based upon homoatomic and heteroatomic structures, polymers containing boron and nitrogen, addition polymers of borazines, polymeric phosphorus compounds and condensed phosphates.

Chem-514 CHEMISTRY OF NONAQUEOUS SOLVENTS 2+0 SEM. I

Acid-base theories, HSAB approach; types of acid-base reactions, acid catalysis, base catalysis, acid-base and redox reactions, levelling effect; classification and characteristics of non-aqueous solvents; types of reactions in ionizing solvents; study of some typical solvents like liquid NH₃, liquid SO₂, H₂SO₄ etc.; coordination model of solute-solvent interaction; study of chemical reactions in molten salts; thermo-chemical studies in non-aqueous solvents.

Chem-515 NUCLEAR CHEMISTRY 3+0 SEM-II

Nuclear particles-stable and unstable; nuclear binding energy and mass defect; nuclear forces and stability-shell and liquid drop models; natural and artificial radio-activity, disintegration series, disintegration rate and half life; types of nuclear reactions-nuclear fission and nuclear fusion; radio isotopes-their production and application in industry, agriculture, medicine and research, principle of working of GM counters and scintillation counters; types of nuclear

reactors; nuclear wastes and their disposal; boranes preparation, structure and bonding, borane anions and carboranes, metal complexes of carborane anions, boranes with hetero atoms other than carbon.

- Chem-517** **INORGANIC PREPARATIONS AND ANALYSIS** **0+2** **sem. II**
- Preparation of inorganic complexes like $\text{Co}\{\text{Hg}(\text{SCN})_4\}$, $\text{Hg}[\text{Co}(\text{SCN})_4]$, $\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$, $[\text{Cu}(\text{Gly})_2]$, $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$, $[\text{Co}(\text{acac})_3]$, $\text{K}_4[\text{Co}_2(\text{C}_2\text{O}_4)_4(\text{OH})_2]$, $\text{K}_2[\text{Cu}(\text{C}_2\text{O}_4)_2]$, $[\text{Co}(\text{NH}_3)_4]\text{SO}_4$ and $\text{Na}_3[\text{Co}(\text{NO}_2)_6]$ and determination of their magnetic characteristic, analysis of alloys using conventional physical and chemical techniques; complexometric titrations.
- Chem- 521** **PHYSICAL ORGANIC CHEMISTRY** **3+0** **Sem-I**
- Stereochemistry and conformation analysis-conformation and configuration, geometrical and optical isomers, methods of resolution, asymmetric synthesis, ORD and CD; aromaticity; steric effects; reactive intermediates, carbocations, carbanions, free radicals, carbenes, arynes, nitrenes; organic reaction mechanism, substitution, addition elimination and rearrangement reactions, substituent isotope solvent and kinetic salt effects, tracer technique, Hammett equation non-classical carbonium ions. Neighbouring group participation; pericyclic reactions and molecular orbital symmetry.
- Chem-522:** **REACTIONS, REAGENTS AND PHOTOCHEMISTRY** **3+0** **Sem,II**
- Backman, Claisen, Fries, Wagner-Meerwein rearrangement; Claisen condensation, Dieckmann, Reformatsky, Curtius, Friedel-Crafts, Mannich, Michael, Pinner, Kolbe, Reimer-Tiemann, Hofmann, Diels-Alder, Arndt-Eistert, Wittig reactions, Aldol condensation, Benzilic acid and Benzidine rearrangements, Acetoacetic, malonic ester and Grignard syntheses. Reagents in organic syntheses- Cu , CuX , Zn , Mg , Li , ZnCl_2 , AlCl_3 aluminum alkoxide, LiAlH_4 , Na , RONa , Ni , SeO_2 , BX_3 , NaBH_4 , CH_2N_2 , HIO_4 , organometallic compounds. Photochemistry-Energy levels, quantum yield, photochemistry of simple organic molecules, Barton reaction.
- Chem-523** **NATURAL PRODUCT CHEMISTRY** **3+0** **Sem-I**
- Structures and syntheses of terpenes-geraneol, citral, myrcin, α -terpeneol, α -pinene, camphor, squalene and abietic acid; isoprene rule; biogenesis of mono, di- and tri terpenoids; synthesis and biogenesis of β -carotene, steroids-cholesterol, ergosterol, sex hormones, progesterone, testosterone, cortisone; plant hormones: auxin B and A, kinetin, abscisic acid, gibberellins; alkaloids- general structural determination, atropine, quinine, reserpine, morphine, nicotine, ephedrine, cocaine; acetogenins-anthocyanins, flavones, flavonols, isoflavones, quinones, chalcones, coumarins, euxanthones, biogenesis of flavonoids; porphyrins, haem, chlorophyll; structures of starch and cellulose.
- Chem-524** **DRUGS AND DYES** **3+0** **Sem-II**
- Principles of drug design and QSAR; chemistry of antibiotics, sulpha drugs, antimalarials, anthelmintics, CNS depressants and stimulants, hypnotics, sedatives, tranquilisers, analeptics, hallucinogens, diuretics, CVS agents, antiallergic, analgesics, anti-inflammatory, antifertility and anticancer agents, prostaglandins and vitamins; chemistry of some important classes of dyes; colour and chemical constitution.

Chem-525	BIOORGANIC CHEMISTRY	3+0	Sem-II
	Elementary structure and function of proteins and nucleic acids. Bioorganic chemistry of aminoacids and phosphates, mechanism of enzyme action, enzyme models, host-guest complexation chemistry, enzyme design using steroid template and remote functionalisation, chemistry of lipids and membranes, transport phenomenon, ionophores.		
Chem-526	SYNTHESIS AND CHARACTERIZATION OF ORGANIC COMPOUNDS	0+2	Sem-II
	Separation and identification of the components of binary organic mixture; synthetic preparations involving two steps; quantitative analysis of phenol, aniline, sulphur, nitrogen; isolation experiments.		
Chem-527	CHEMISTRY OF PESTICIDES	2+1	Sem-II
	Classification of pesticides on the basis of function, mode of entry and mode of action; chemistry and structural activity relationship of different pesticidal compounds i.e (I) Insecticides-organochlorines, organo-phosphates, carbamates, pyrethroids, rotenones and stereochemistry of botanicals, (ii) Fungicides-Inorganics, dithiocarbamates, phthalimides-organophosphates, diazoles and exathions (iii) Herbicides-phenoxy compounds, substituted ureas, sulfanyl ureas, triazines, bipyridylum compounds and dinitroanilines; metabolic pathways of some important compounds of each chemical group. Practical: Testing of pesticidal formulations from point of view of their quality; estimation of active principles of pesticides employing different analytical techniques in different matrices.		
Chem-601	TOPICS OF CURRENT INTEREST	3+0	Sem-I
	Polymer Chemistry, macromolecules, catalysis and solid state chemistry.		
Chem-602	ADVANCE PHYSICAL CHEMISTRY	3+0	Sem-II
	Application of computers in Chemistry, advanced quantum mechanics and spectroscopy-II.		
Chem-611	ORGANOMETALLIC CHEMISTRY	3+0	Sem-I
	Introduction, synthesis and structure of metal alkyls, metal aryls, metal carbonyls, metal carbenes and metal carbynes; complexes with chain pi donor ligands and cyclic pi donor ligands; reaction pathways-association reactions, substitution reactions, addition and elimination reactions, re-arrangement-reactions, catalysis involving organometallic compounds-olefin hydrogenation, hydroformylation, the Wacker process, polymerization, the Fischer-Tropsch process, cyclo-oligomerisation of olefins and acetylenes etc.		
Chem-612	BIO-INORGANIC CHEMISTRY	2+0	Sem-II
	Inorganic elements in biological systems; importance of alkali and alkaline earth metals, ions and ligands affecting the stability of complexes, coordinating sites in biologically important ligands such as purines, pyrimidines, nucleosides, nucleotides, amino-acids and peptides; metalloenzymes and metal activated enzyme, metal complexes as oxygen carriers-haemoglobin, myoglobin; non-porphyrin oxygen carriers-hemocyanin and hemerythrin; synthetic oxygen carriers non-redox metallo-enzymes, mechanism of electron transfer reactions in metal complexes as drugs and anticancer agents.		

Chem-613	CONSTITUTION OF INORGANIC COMPOUNDS AND DYNAMICS OF INORGANIC REACTION	2+0	Sem-II
	Symmetry of crystals, crystal system, classes of crystals, types of lattices, lattice energy, point group and space groups, symmetry parameters, defects in solids, structure of some typical binary and ternary compounds, structure of silicates, polyacids and their salts; introduction to determination of crystal structure by X ray diffraction, electron diffraction and neutron diffraction techniques; thermodynamics, kinetics and spontaneity of reaction, Frost diagram and its relation to spontaneity and application in the prediction of chemical reactions.		
Chem-621	ORGANIC SYNTHESIS	3+0	Sem-I
	Synthesis and synthetic equivalents, formation of C-C, C-N and C-halogen bonds, multistep synthetic strategy and catalysis, 3-7 membered heterocycles, synthesis and reactivity of furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline and indole, skraup synthesis, Fisher indole synthesis; natural and synthetic polymers, different types of polymerization reactions, rubber, nylon and polyester.		
Chem-622	SPECTROSCOPY IN ORGANIC CHEMISTRY	3+0	Sem-II
	UV-principle, solvents and their effects, chromophores, auxochromes, effect of conjugation, absorptions in polyenes, dienes, haloketones, enones, aldehydes, unsaturated acids, esters, benzenoid aromatics, heterocycles; IR-absorption process, functional group and finger print regions, combination and overtone bands, Fermi resonance interpretation; ¹ H NMR-principle, resonance, chemical shifts, shielding and deshielding, equivalence of protons, splitting, n+1 rule, coupling constant, interpretations, shift reagents; ideas of ¹³ C NMR, ¹⁵ N NMR, ¹⁹ F NMR, ³¹ P NMR, MS-metastable ion, nitrogen rule, molecular mass determination, reaction pathways, fragmentation patterns, retro Diels Alder fission, McLafferty rearrangement, fragmentation in hydrocarbons, alcohols, phenols, ethers, aldehydes, isomer, ester, carboxylic acids, amines, nitro, amides, nitriles, GCMS, CIMS, FABMS; Electron Spin Resonance(ESR).		
Chem 591	Seminar	1+0	Sem I and II
Chem 600	Master's Research		
Chem 700	Ph. D. Research		

DEPARTMENT OF LANGUAGES & HARYANVI CULTURE

UNDERGRADUATE COURSE

ENG-101	APPLIED GRAMMAR AND PRECIS WRITING	3+1 SEM. I / II
	<p>A text for detailed study (Grammar based prepared by CIEFL, Hyderabad) (i) Short answer questions on contents of lessons; (ii) Objective type questions to test the understanding of the lessons.</p> <p>Practical: Usage, composition and listening comprehension I) Usage: part of speech, tenses, auxiliaries, narration, voice, homonyms, synonyms and antonyms; (ii) Composition: précis writing, paragraph writing, letter writing, translation from Hindi into English.</p>	
ENG-102	ENGLISH AND TECHNICAL WRITING	1+1 SEM. II
	<p>1. Grammar-Advanced exercises on prepositions, tense usage and passive voice.</p> <p>2. Comprehension- Text Book: Language Through Literature-2.</p> <p>Chapters Prescribed: (i) Prankster of the Sea; (ii) The Power of Women; (iii) A Scramble Among the Tagins; (iv) The Night the Ghost Got in.</p> <p>3. Composition- Writing of personal letters, writing of technical reports on subjects connected with Home Science.</p> <p>Practical: Spoken English: Phonetics: vowels, diphthongs and consonants, word stress, writing and presentation of technical reports, group discussion and debate on current topics and on Home Science subjects to develop oral communication skills.</p>	
ENG-103	STRUCTURAL AND SPOKEN ENGLISH	1+1 SEM. I
	<p>Error analysis, concord, collocation, preposition, acronyms, classified ads and circulars, formal correspondence on technical and other subjects; report writing on technical topics, comprehension (text based).</p> <p>Practical: Phonetics symbols, and phonetic transcription, stress pattern, weak forms of words, communicative value of sentences, use of dictionary and encyclopedia, facing an interview, speaking on a given topic, impromptu presentation.</p>	
ENG-302	TECHNICAL WRITING	1+1 SEM. VI
	<p>Reading comprehension: Factual, formulating, translating, global comprehension, language in use in terms of synonymy's, antonyms, collection in context, introduction to different types of writing-descriptive, narrative and expository, letter writing-formal and informal, speech acts, norms of preparing introductory address, presidential address, vote of thanks.</p> <p>Practical: Integrated grammar by means of class exercises, common errors in English writing, use of cohesive devices, dialogue practice-orientation to different types of letters, performing different speech acts according to contexts, exercises based on examinations like TOEFL, GRE and GAT.</p>	

POSTGRADUATE COURSES

FL-501 RUSSIAN LANGUAGE	3+0 SEM. I / II
	<p>Russian alphabet; hard and soft consonants, vowels; Russian nouns denoting animate beings and inanimate objects; the stem and endings of nouns; gender</p>

and plural of nouns; pronouns; personal possessives and demonstratives; verbs; present tense e-conjugation and u-conjugation; past and future tense; aspects of verbs: present, past and future; adjective; adverbs of manner and place; and word order in a Russian sentence; case-nominative; prepositional accusative, genitive; dative and instrumental; words and meanings; antonyms; translation of simple sentences from Russian into English and vice-versa.

15 lessons from book 'Russian' by Vagner.

FL-502 FRENCH LANGUAGE

3+0 SEM. I / II

French alphabet and its pronunciation; place of accent in French language; articles and its uses; gender and number of nouns; types of adjectives and pronouns; formation of adverbs; use of prepositions; conjunctions; verbs with avoir and etre, verbs of different groups; tenses: present, past, future; counting 1 to 100.

Translation of simple passage from French into English and vice-versa; chapter 1 to 21 to be taught from the text books 'Course de Langue Et de Civilisation Française' Part-1 by G. Mauger for practice in pronunciation and grammar.

FL-503 GERMAN LANGUAGE

3+0 SEM. I / II

German alphabet; consonants and vowels; combined consonant sounds and combined vowel sounds; gender of nouns; agreement between subject and verb; use of definite and indefinite articles for nominative; accusative; dative and genitive cases; use of various pronouns; declination of nouns; prepositions with accusative or dative or with both or with genitive; modal verbs; making sentences in simple present, simple past, present perfect and past perfect tenses; use of adjectives for comparison, conjunctions, passive voice; translation of a simple passage from German into English; selected chapters to be taught from the text "Deutsche Sprachlehre für Ausländer Gundstufe I Teil".

MGT-507

WRITTEN ANALYSIS AND COMMUNICATION

2+1 SEM. I

Role of written and oral communication in business; types of communication; essentials of effective communication; barriers to effective communication: different methods, media and processes of communication with individuals and groups; periodical progress reports; investigative and research reports.

Practical: Written practice in communication; group discussion for oral practice.

CCR-551

CERTIFICATE COURSE IN RUSSIAN

0+3 SEM. II / II

PHONETICS: Sounds and letters; reduction of vowels; voicing and devoicing of consonants; stress; intonation of simple sentences.

Grammar: Nouns, pronouns and adjectives in all the cases in singular and plural (including soft endings). Verb: Imperfective: present, past and future; perfective: past tense (future tense for passive knowledge only); use of imperatives; use of short adjectives; numerals: cardinals 1 to 100. ordinals 1 to 20, use of ordinals in other cases.

Active and passive lexis: 1200 words.

HINDI & HARYANVI CULTURE

DEPARTMENT OF GENETICS

Field of Specialization for M.Sc. and Ph.D. : Population/Biometrical Genetics, Microbial/
Molecular Genetics, Biochemical Genetics,
Cytogenetics, Plant tissue culture

Required Courses

M.Sc. : Genet. 501, Genet.502, Genet.503, Genet. 504,
Genet. 505, Genet.506,Genet. 591
Supporting Courses : Stat.401, Biochem. 451 and other courses recommended
by Advisory Committee of the student
Minor courses : As recommended by Advisory Committee of the student.
Ph.D. Required courses of M.Sc. if not taken earlier. Genet. 601
and Genet. 591

UNDERGRADUATE COURSES

GENET-101 INTRODUCTORY GENETICS 1+1 SEM. I

Heredity and variation; Mendel's laws of inheritance: Gene interactions, penetrance, expressivity, pleiotropism; Sex chromosomes, sex linked, sex influenced and sex limited characters; Linkage and crossing over; Quantitative inheritance; Structural and numerical changes; Extra nuclear inheritance; Nature, structure and replication of genetic material; Genetic code and protein biosynthesis; Regulation of gene action; Hardy-Weinberg equilibrium.

Practical: Life cycle of some important organisms; Preparation and demonstration of mitosis and meiosis cell division slides; Numerical problems on Mendelism, gene interactions, sex linkage, gene mapping in diploids and Hardy-Weinberg Law; Practical demonstrations of Mendelian segregation of mono and dihybrid crosses in crop plants.

GENET-401 ELEMENTARY GENETICS 3+0 SEM. I

(Students intending to take Genet-501 as credit course for minor subject should not take this as credit course)

Beginning of genetics; Mendel's laws; Chromosomal theory of inheritance; Gene interactions; Linkage and crossing over; Gene mapping in diploids; Recombination in prokaryotes; Sex determination and sex linkage in diploids; Quantitative inheritance; Extra chromosomal inheritance; Numerical changes in chromosomes; Chromosomal aberrations; Mutations and mutagenic agents; Nature of gene; Genetic fine structure; DNA structure and replication; Genetic code; Protein biosynthesis; Organization of DNA in chromosomes; Gene regulation; Transposable genetic elements; Genetics and evolution; Somatic cell genetics; Recombinant DNA technology.

GENET-402 ELEMENTS OF CYTOLOGY AND CYTOGENETICS 2+1 SEM. II

A detailed account of generalized cell; Cell organelles, their ultrastructure and function; Cell division and cell cycle; Chemistry of nucleus and chromosomes; Heterochromatization and gene expression; Chromosome- its shape and structure; Unusual chromosomes; Cytology and Mendelism; Cytological basis of linkage and crossing over; Somatic crossing over and unequal crossing over; Sex chromosomes, sex-determination and sex differentiation; Numerical and structural changes in chromosomes; Spontaneous and induced mutations; Genome analysis, evolution of karyotypes.

Practical: Killing, fixation and preservation of material for cytological studies; Preparation of some important stains; Squash and smear preparation for

patterns of variation and phylogenetic relationship of crop plants viz., wheat, rice, maize, sugarcane, *brassica*, cotton, pulses, forages etc. and their related species; Distant hybridization including interspecific and intergeneric crosses, problems and perspectives.

Practical: Principles and working of different types of microscopes; Study of cell division and chromosomal aberrations in crop plants with light microscope; pollen viability and culture; Photomicrography; Study of polytene chromosomes in *Drosophila* / maize, sex chromatin studies.

GENET-503 MICROBIAL AND MOLECULAR GENETICS 3+1 SEM. I
(Pre-requisite: Genet-401 or Genet-501)

Regulation of gene activity in procaryotes; Molecular mechanisms of mutation repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Gene isolation, synthesis, sequencing, cloning, genomic and cDNA library; Nucleic acid hybridization and immuno-chemical detection; Chromosome walking, RFLP, RAPD and PCR approaches; Molecular markers for crop improvement; Recombinant DNA technology; Anti enzymes RNA and ribozymes; Gene silencing; Genetics of nitrogen fixation; Split genes, overlapping genes, oncogenes, pseudogenes and gene families; Genetics of mitochondria and chloroplasts, DNA restriction and methylation (M-R system).

Practical: Handling of microorganisms for genetic experiments; Quantification of microbial growth; Induction of mitotic crossing over and gene conversion in yeast; Complementation studies in yeast; Induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria; Tn mediated mutagenesis; Analysis and isolation of plasmid DNA; Transformation of bacteria with plasmid DNA; Curing of plasmid; Handling and characterization of phages.

GENET-504 PRINCIPLES OF POPULATION GENETICS 2+1 SEM. II
(Pre-requisite : Stat-401)

Population and role of population genetics; Probability applied to Mendelian inheritance; Hardy-Weinberg law and forces influencing gene frequencies; Selection, mutation, migration, population size, gene conversion and meiotic drive; concept of natural, idealized and non-idealized population; Wahlund's principle; Snyder's ratio; Genetic loads and cost of natural selection; Electrophoretic variants of protein in the study of population genetics; Linkage disequilibrium concept and measurement of inbreeding and heterozygosity; Wright's approach in contrast to Malecot's approach; Generalized zygotic distribution and genetic variance under inbreeding; Equilibrium under selfing and random mating combined; Recurrence formulae under different systems of matings; mating systems and their genetic consequences; Fisher's theorem of natural selection; Polymorphism; Multiple factor inheritance, polygenes and continuous variation; casual components of variation; Covariance between relatives; parents-offspring regression; theory of pathcoefficient applied to population genetics.

Practical: Estimation of gene frequencies; Genetic exercises on probability; Exercises on factors affecting gene frequencies and path coefficient.

GENET-505 GENETICS OF STRUCTURE POPULATION 2+1 SEM. I
(Pre-requisite : Stat. 401)

Parameters of population structure; Basic concepts and estimation of gene effects; Types of variation; Types of selection; Genetic consequences of different modes of selection; Correlation and correlated responses and its

prediction in various modes of selection; Biometrical parameters-heritability, degree of dominance, number of effective factors, etc., their significance and estimation, mating designs; NC designs, diallel and the line x tester, their genetic interpretations; Combining ability concept of linkage and its detection; Genetic basis of heterosis; Scales-threshold characters; Selection methods-tandem, culling and multiple trait selection; random and fixed effect, genotype-environment interaction and adaptive values of genotypes; homeostasis; introduction to genetic divergence - D2.

Practical: Exercises of different mating designs; Estimation of different population parameters from experimental data.

GENET-506 DEVELOPMENTAL GENETICS 3+0 SEM. II

History and scope: Theory of cell differentiation - Genome constancy - indirect and direct evidences for differential gene expressions; Genome control in embryogenesis; Maternal control in early development; Localization and molecular mechanisms of morphogenetic determinants in egg cytoplasm; Determination; transdetermination; regeneration in plants and animals; chromatin and nuclear proteins; chromosomal differentiation; nucleo-cytoplasmic interactions; long lived mRNA; differentiation in slime molds and *Acetabularia*; morphogenesis in viruses and bacteria; repeated DNA sequences; gene regulation in eukaryotes; regulation of RNA synthesis; differential enzyme synthesis and degradation; LDH system; hormone induced cellular functions in plants and animals; Gene amplification; homeotic genes; double fertilization; embryo and endosperm development; Tissue differentiation and pattern formation; seed storage protein synthesis; human genetic disorders.

GENET-507 CELL BIOLOGY 3+0 SEM. I

Cell theory: Chemical organisation of the cells; cellular organisation in prokaryotes and eukaryotes; organisation of plasma membrane and other cell membranes; membrane function; endoplasmic-reticulum; Mitochondria, chloroplast, microbodies and lysosomes; structure and function of ribosomes; chemistry and ultrastructure of interphase nucleus and chromosomes; regulation of cell division; spindle apparatus, synapsis; chromosome movement; cell movement; functional organisation of cilia and flagella; centrioles; microtubules; amoeboid movement.

GENET-509 CYTOLOGICAL TECHNIQUES 0+3 SEM. II

Microscopy; autoradiography and microspectro-photometry; karyotype analysis; histochemical techniques; pollen tube growth studies; handling of mutagens; different laboratory organisms and their use in genetic experiments; differential staining techniques; principles of electron microscopy; fixation and embedding of biological material for electron microscopy; ultramicrotomy; staining procedure; study of ultrastructure of cell.

GENET-601 ADVANCED GENETICS 3+0 SEM. I

Gene regulation in prokaryotes; Lac operon-negative and positive regulation; Genetics of mutants of promoter and regulator region; Gal operon; Genetic elements of gal operon, possible value of two promoter R; arabinose operon; Trp operon-repressor-operator-system; mechanism of attenuation; repressor versus attenuation; concept of regulons; IITP, pH and SDS regulon; regulation of lytic eukaryotes; Genetic control of antibody diversity; Regulatory units in yeast; Mechanisms of genetic recombination; Models for general homologous recombination; Site specific recombination in bacteriophage, flagellar antigen

switching in *Salmonella*; mating type switching in *S. cerevisiae*; non-specific recombination; Polymorphism; Methods of studying polymorphism at biochemical and DNA level; genetic control of polymorphism; evidence for selectionist and neutralist; Genetics of cell organelles mitochondria and chloroplasts; discussion on complex loci with reference to gene concept.

GENET-602	ADVANCED CYTOLOGY AND CYTOGENETICS	3+0	SEM. II
	Chromosome structure; chromosome movement; chromosome pairing and segregation; cytogenetics of some important crops and man; genome analysis; genetic and biochemical control of cell division; cytogenetics of cultured cells; somatic cell hybridization; protoplast technology; <i>In vitro</i> fertilization; cell mutagenesis; cytogenetics in relation to biotechnology.		
GENET-603	ADVANCED POPULATION GENETICS	3+0	SEM. II
	Mating designs; genetic basis of triple test cross analysis (TTC); Triallel analysis; partial diallel crosses and mating design for studying reciprocal and maternal differences; models for studying the inheritance of endosperm characters; classificatory problems; discriminant function, D2 analysis; principal component analysis; use of genetic parameters for prediction of recombinant inbred lines; advance in studies of genotype environment interaction and selection indices; generation matrix and its use in population genetics; gene mapping of QTL (quantitative trait loci).		
GENET-604	MUTAGENESIS	3+0	SEM. I
	History of mutagenesis; Test systems for screening of mutagens; molecular mechanisms of spontaneous and chemical mutagenesis; mutational specificity; intragenic mutational spectra and hot spots; site directed mutagenesis and its applications; mutator genes; mutagenesis by apurinic and apyrimidic sites; somatic mutations; molecular basis of repair and suppression; repair and mutagenesis; environmental mutagen testing.		
GENET-591	SEMINAR	1+0	SEM. I/ II
GENET-600	MASTER'S RESEARCH		
GENET-700	Ph.D. RESEARCH		

DEPARTMENT OF MATHEMATICS & STATISTICS

Field of Specialization for M.Sc. and Ph.D. : Stochastic Processes, Design of Experiments, Genetic Statistics, Sampling Theory, Statistical Inference, Linear Models, Regression Analysis and Time Series.

Required Courses

Ph.D. (Statistics) : Stat 602 and Stat 603
M.Sc. (Statistics) : Stat 501, 502, 505, 506/508, 507, 509, 511, 512 and Stat-407 (Non Credit) IMI 501, IMI 506, genet 401

Gene and genotypic frequency, Hardy-Weinberg law; Migration, mutation and selection; Detection and estimation of linkage for qualitative characters in backcross and F_2 data; Tests for segregation ratios, polygenic system for quantitative characters; Genetic variation and its partition into different components, tests of genetic hypotheses, path analysis, heritability, repeatability, breeding value; Compact family block designs, discriminant function for plant selection, systems of matings; Effect of inbreeding and cross breeding in finite population; Selection, response to selection, genetic advance, estimation of effective number of genes.

Stat-407 **MATHEMATICS STATISTICS** **3+0** **Sem-I**

Probability of its laws, combinatorial problems; Random variable, probability distribution of random variables, mathematical expectation, moments and cumulants, moment generating and characteristics functions; Probability distributions – Binomial, Poisson, Negative Binomial, Geometric, Hypergeometric, Multinomial, Uniform, Exponential, Normal, Gamma, Beta; Concept of sampling distributions, chi-square, Student's t and F-distributions; concepts of parameter estimation and testing of hypotheses, parametric and non-parametric hypotheses; Bivariate distribution, simple, multiple, partial and rank correlation coefficients, utility of Kendall Tau; Simple and multiple regression, principle of least squares and curve fitting; Theory of attributes, Analysis of cross tabulated data; Analysis of variance for one-way and two-way classifications.

Stat-408 **BIOSTATISTICS AND COMPUTERS** **2+1** **Sem-I**

(Bio-Technology programme)

Aims, scope and idea of elementary statistics; Measures of central tendency and dispersion, skewness and kurtosis; Concept of probability and probability laws, mathematical expectation, moments, moments generating function; Standard probability distributions – Binomial, Poisson and Normal distributions, tests of significance based on z, χ^2 , t and F statistics; Correlation and regression, curve fitting by least squares methods; Basic principles, organization and operational aspects of computers, operating systems, machine language, high level languages; information representation; Writing programs in BASIC language for correlation, regression and curve fitting; Data processing on spreadsheets.

Stat-409 **STATISTICAL METHODS FOR SOCIAL SCIENCES** **2+1** **Sem-II**

Cumulative frequency graph, percentiles, different scales, validity and reliability tests, scaling of test items; Reliability of test scores, rank correlation, association and testing of independence in 2x2 and mxn tables; Non-parametric tests – Sign test, run test, median test; Mann Whitney test, Wilcoxon test.

Practical:Based on above topics.

Stat-410 **MULTIVARIATE STATISTICAL METHODS FOR BIOLOGICAL WORKERS** **2+1** **Sem-II**

(Pre-requisite: Math-403 and Stat-401)

Overview of multivariate methods, concepts of random vector, mean vector and variance-covariance matrix and correlation matrix; Multiple regression, p-variate linear models; Multivariate normal distribution; Hotelling T^2 ; Classificatory problems and discriminant function, D^2 -statistic and its applications; Selection indices; Multivariate analysis of variance; Principal components and canonical correlations.

Practical:Based on above topics.

Stat-411 THEORY OF CORRELATION AND REGRESSION 3+0 Sem-I
ANALYSIS

(Pre-requisite: Stat-401/Stat-407)

Introduction to correlation analysis and its measures; Correlation from grouped data, Biserial correlation, Rank correlation; Testing of population correlation coefficients; Multiple and partial correlation coefficients and their testing; problem of correlated errors; Auto correlation; Durbin Watson Statistics; Removal of auto correlation by transformation; Analysis of collinear data; Detection and correction of multicollinearity; Regression analysis; Method of least squares for curve fitting; Testing of regression coefficients; Multiple and partial regressions; Examining the multiple regression equation; Concept of weighted least squares; regression equation on grouped data; Various methods of selecting the best regression equation; regression approach applied to analysis of variance in one way classification; Heteroscedastic models, Concept of nonlinear regression and fitting of quadratic, exponential and power curves; Economic and optimal dose, Orthogonal polynomial.

Practical:Based on above topics.

Stat-501 PROBABILITY THEORY AND PROBABILITY 3+0 Sem-I
DISTRIBUTIONS

Elements of measure theory, sample space, probability-classical, empirical and axiomatic definitions, conditional probability and Bayes Theorem; Random variables and their probability distribution, mathematical expectation; Moment generating function, characteristics function and probability generating functions, cumulants, uniqueness theorem, inversion theorem; Types of convergences, Chebyshev's inequality, weak and strong laws of large numbers; Jensen's and Holder's inequalities; Probability distributions – Binomial, Poisson, Negative Binomial, Geometric, Multinomial, Uniform, Normal, Cauchy, Gamma, Beta, central and non-central χ^2 , t and F distributions; Path analysis, genetic gain under three methods of selection, correlated response, simultaneous selection for several characters; Stochastic process of gene frequency change; Concept of general combining ability and specific combining ability, diallel and partial diallel crosses, Line x tester analysis, North Carolina designs, analysis of multiway cross design, simulated population, progeny row trials and compact family block designs.

Stat-513 STATISTICAL INFERENCE - II 3+0 Sem-II

(Pre-requisite: Stat-503)

Sufficient statistic, minimal sufficiency, completeness and minimum variance unbiased estimation; Bayesian concepts, methods of coring for the estimation of parameters, fiducial and confidence intervals, admissibility of tests and estimators; Tests of composite hypotheses in case of monotonic likelihood ratio, asymptotic distribution of L-static and its properties; Sequential tests, sequential estimation, Stein's two sample procedure; Robust estimation; Distribution free tests; Wald's test, Kolmogorove-Smirnov test, test for one way classification.

Stat-514 CATEGORICAL DATA ANALYSIS AND BIOASSAYS 3+0 Sem-II

Sampling models for discrete data; Fisher's exact tests, Gart's test for residual effects; Elements of information theory, analysis of information, measures of association, log-linear models; Interval proportion fitting, collapsing multi-dimensional tables, conditional independence and logistic regression, probit analysis, bio-assays, quantitative and quantal responses, estimation of potency, dosage-response curve.

Stat-515 STATISTICAL COMPUTING 2+1 Sem-II

History and literature of statistical computing, computer hardware operating characteristics, computer software and programming, floating point arithmetic and introduction to general simulation methodology, variance reduction procedures, Monte-carlo methods; Approximations to probabilities, percentiles and other special functions; Numerical methods, linear least squares computation-constrained and unconstrained; Non-linear squares-constrained and unconstrained; Alternatives to least squares such as L_4 or L_p optimality criteria.

Practical:Based on above topics.

Stat-516 DESIGN OF EXPERIMENTS – III 3+0 Sem-II

(Pre-requisite: Stat-505)

Fundamentals of response surface technology, response optimization and slope estimation; Orthogonal and balanced arrays, fractional replication, regular and irregular fractions; Balanced factorial experiments-symmetrical and asymmetrical factorials; Row-column designs, augmented designs and optimal designs.

Stat-601 STOCHASTIC PROCESSES 3+0 Sem-I

Discrete and continuous stochastic processes, generating functions, renewal process (recurrent events); Markov chains, algebraic treatment of finite markov chains, random walk, branching process (discrete); Poisson process, birth and death processes, migration process, applications to queues and epidemics.

Stat-602 THEORY OF LINEAR HYPOTHESES 3+0 Sem-II

Theory of linear estimation, construction of confidence ellipsoids and tests in the general case, multiple comparison, linear hypotheses, analysis of multiple classification data, generalized inverse and its applications, variance components, methods of estimating variance components from unbalanced data, maximum likelihood for mixed models.

Stat-603 ADVANCED MULTIVARIATE-ANALYSIS 3+0 Sem-II

(Pre-requisite: Stat-511)

Various calculus: Differentiation of vectors; directional derivatives, line, surface and volume integrals. Statement of Gauss, Green's and Stoke's theorems and their application. Differential equations. Differential equations of first order first degree; Linear differential equations with constant coefficients. Homogeneous equations with variable coefficients; application to practical problems. Bessel's and Legendres differential equations. Partial differential equations; Matrices: Basic properties, transpose, adjoint, inverse and rank of a matrix, solution of equations, elementary transformations, characteristic equation, Cayley-Hamilton theorem.

Math-201	MATHEMATICS-III	3+0	Sem-I
	(For B. Tech. Agri. Engg.)		
	Laplace transforms: Laplace transform of standard, unit, step and periodic functions. Inverse laplace transform. Convolution theorem; Applications of Laplace. Transformations to solution of ordinary differential equations with constant coefficients.		
	Complex analysis: Analytic functions; Cauchy-Riemann equations. Conformal mapping; complex integration. Cauchy's fundamental theorem; residues; cauchy-residue theorem. Jordans' lemma. Contour integration.		
	Fourier series. Dirchlets' condition Fourier's theorem.		
	Numerical analysis: Errors and approximation; finite differences; finite difference operations; integration; first and second order linear finite difference equations with constant coefficients. Interpolation methods for solving simultaneous linear algebraic equations.		
Math-401	DIFFERENTIAL CALCULUS	3+0	Sem-I
	Function, limit and continuity of function, differentiation and its applications in small errors and approximate calculations; approximate solution of equation and indeterminate forms; successive differentiation; Mean value theorems, partial differentiation; tangents and normals; Curvature; maxima and minima of one and more than one variables.		
Math-402	INTEGRAL CALCULUS AND DIFFERENTIAL EQUATIONS	3+0	Sem-II
	Integral calculus; Integration of irrational algebraic functions and transcendental functions; reduction formulae; definite integrals; area under curves; differential equations of the first order and the first degree; Differential equations of first order, but not of first degree; Liner equations with constant coefficient, partial differential equations and applications of differential equations, Laplace transforms and Fourier integrals.		
Math-403	MATRIX ALGEBRA	3+0	Sem-II
	Introduction to matrix and basic operations on matrices; special matrices; Determinants, Transpose and conjugate transpose of a matrix; inversion and portioning of matrices; rank and solving equations by the use of matrices; characteristic roots and vectors; canonical forms and generalized inverses; quadratic forms; applications.		
Math-404	APPLIED MATHEMATICS	4+0	Sem-I

Algebra of sets of functions; quadratic equations, complex numbers; Cis and De Moivre's theorem; Binomial theorem; Arithmetic and geometric series; Physical and geometrical interpretation of derivative, differentiation of functions of various types; Maxima and minima; Rolle's theorem and Taylor's expansion; Partial differentiation; method of Lagrange multipliers; Ordinary differential equations; concept of boundary values, integration as inverse process of differentiation and the mean value theorem; Methods of integration; Line integrals; Fourier and Laplace transforms; Matrices, addition and Multiplication; Elementary transformation and its application; Matrix inversion; Rank, diagonalization and eigen value problems; Vectors; concept of normalization and orthogonality; Physical significance of divergence, gradient and Curl; Gauss's and Stoke's theorems with their applications; Tensors: Gamma and Beta functions; Lagrange and Laguerre's polynomials; Bessel functions; Direct Delta functions with their applications in physico-chemical phenomena. Classical inequalities; definition and theorems of group theory; Link between group theory and quantum mechanics. Applications to molecular geometry; Molecular spectre and molecular reactivity; Solution of equations and simultaneous linear equations; Numerical integration; Differentiation equation; Eigen vector problem; Jacobi's method; Atomic structure calculations.

Math-405 REAL ANALYSIS 4+0 Sem-I

Number system; Neighbourhood, interior and limit point in \mathbb{R} ; Open and closed sets with their properties; Bolzano-Weierstrass theorem, Heine-Borel theorem; Properties of continuous functions; Rolle's, Lagrange's, Cauchy mean value theorems, Taylor's and Maclaurin's series; Real sequences and their convergence; Cauchy's sequence, Cauchy's general principle of convergence; Comparison, ratio, root, integral, Leibnitz's, Raabe's, Gauss and Cauchy's condensation tests for the convergence of series; Notion of uniform convergence.

Definition and existence of Riemann's integration of bounded functions. Condition of integrability; Riemann's integral of continuous, Monotonic with finite number of discontinuities; fundamental theorems of integral calculus, first and second value theorems.

Math-406 APPLIED MATHEMATICS (FOR FST) 2+0 Sem-I

Quadratic equations T-ratios and their relations, derivative; Theorems on derivative, derivative of composite function; Derivatives of Trigonometrical, inverse trigonometrical functions, logarithmic and exponential functions, of a function; Integration: Integration by elementary standard formulae

**INDUSTRIAL MATHEMATICS & INFORMATICS
POSTGRADUATE COURSES**

IMI-501 APPLIED LINEAR ALGEBRA 2+1 Sem.I

Vector space, linear dependence and independence; Basis and dimension. Linear transformation, Matrix representation of linear transformations, Rank-nullity theorem, Inverse of linear transformation, Row reduction methods, Solving system of linear equations, Determinants and their properties.

Inner product space, Norm, Gram-Schmidt orthogonalisation, Orthogonal polynomials. Eigen values and eigen vectors of matrices, diagonalization, Hermitian matrix, Unitary matrix, positive definite matrix.

Principles of Least square and pseudo inverse, iterative solutions of linear equations, quadratic forms, linear programming, Markov chain, population growth problem, Evolution equation.

Practical:Solving problem based on the above topics.

IMI-502 ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 2+1 Sem.I

Ordinary differential equations basic concepts; Linear differential equations, various methods of solutions; System of differential equations and their solutions; Solution in series; Orthogonal functions; Eigen value problems; Stability of linear and non-linear systems; Difference equations; Applications of ordinary differential equations to industrial problems.

Partial differential equations, basic concepts and origin of partial differential equations; Linear first order equations – their solutions. Linear equations with constant coefficients; Quasilinear equations successive differentiation, determination of maximum and minimum values by substitution and by parts. Areas and volumes differential equations for the form:

(i) $dy/dx = f(x)$ (ii) $dy/dx + Py = Q$ where P, Q are functions of x . (iii) $dy/dx = x^n f(y/n)$

IMI-503 NUMERICAL METHODS 2+1 Sem.I

Numerical Linear Algebra Direct Methods: Gauss elimination method without and with pivoting. Iterative method jacobi and Gauss-seidel methods, convergence, eigen values and eigen vectors, power method. Solution of nonlinear equation: Newton Raphson and other iterative methods with convergence. Interpolation finite difference operators, difference tables, Newton, Bassel and Starling interpolation formulae, divided difference, Lagrange's and Newton's formula. Numerical differentiation first and second order derivatives. Numerical Integration Trapezoidal rule, Simpsons rule, Gauss-Legendre quadrature formula.

Solution of first and second order differential equations Taylor's Euler's and Runge-Kutta 2nd and 4th order methods, Finite difference approximation of two point boundary value problems. Approximation of functions by method of least squares, by Bernstein polynomials and by splines.

Practical:Solving problems based on the above topics.

**IMI-504/
COMP-502 COMPUTER FUNDAMENTALS 1+2 Sem.I**

Introduction to computer organization, computer generations, input-output units; computer memory system; System and application

Stat-510 THEORY OF ECONOMIC STATISTICS 3+0 Sem.II

Problem and construction of index numbers and their tests, fixed and chain base index numbers, construction of cost of living index number; Time series analysis, decomposition of time series into trend, seasonal variation and cyclic movements, stationary and non-stationary time series, auto regressive and moving processes, auto-correlation and partial auto-correlation functions; Correlogram and periodogram analysis; ARIMA models for non-seasonal and seasonal time series; Economic application of multivariate time series analysis; Demand analysis-demand and supply curves, determination of demand curves from market data, Engel's law and the Engel's curves, income distribution and method of its estimation, Pareto's curve.

Stat-511	MULTIVARIATE STATISTICAL ANALYSIS	3+0	Sem.I
	Multivariate normal distribution, distribution of quadratic forms, conditional and marginal distributions, correlation and regression coefficients; Estimation of parameters, sampling distribution of sample mean vector and sample variance-covariance matrix; Hotelling's \bar{t}^2 , confidence regions, Mahalanobis D^2 , principal component analysis, discriminant function and classification problem.		
Stat-512	THEORY OF GENETIC STATISTICS	4+0	Sem.I
	Some elementary concepts like gene and genotypic frequencies, Hardy Weinberg law, balanced between various forces causing change in gene frequency; Random mating and disequilibrium between forces in large populations, Fisher's fundamental theorem of natural selection, theory of inbreeding, generation matrix, segregation ratios, polygenic systems for quantitative characters, concept of breeding value and dominance, genetic variance and its partitioning, correlation between relatives, epistasis, genotypic and environment interaction, tests of linkage and epistasis, tests of genetic hypotheses, estimation of heritability, repeatability, and genetic correlations; regression and product estimators; Sources of non-sampling errors, their control and estimation; Designs of agricultural and forestry surveys.		
	Practical: Based on above topics.		
Stat-508	THEORY OF SAMPLING TECHNIQUES AND DESIGNS OF SURVEYS-II	3+0	Sem.I
	(Pre-requisite: Stat-507)		
	Further aspects of stratified sampling, demarcation of strata, determination of number of strata, multiple stratification, post stratification; Quota sampling, multi-dimensional sampling, lattice sampling, inverse and successive sampling, PPS without replacement sampling, self weighing design; Relative efficiencies of different sampling techniques considering super population; Use of multi-ancillary information; Treatment of non-sampling errors, non-response errors; Generalized ratio estimators, unbiased, almost unbiased, stratified, chain and double ratio estimators; Planning of large scale surveys.		
Stat-509/ COMP-509	COMPUTER PROGRAMMING IN STATISTICAL RESEARCH	2+1	Sem.I
	Introduction to Computers, Types of Computers, Computer generations and classifications, Computer peripherals, memory units, control units, arithmetic and logic unit, secondary storage.		
	Computer codes – Arithmetic binary system, Octal and Hexadecimal number system, Conversion to Decimal system.		

Computer softwares – Machine language, Assembly language, High level language, Compilers, Interpreters and system utilities, Flowcharting and programming, Debugging, Testing and types of errors.

Formulation of Algorithm, Elements of FORTRAN language, constants and variables, Operations and symbols, Expressions, Common mathematical functions, Arithmetic assignment statement, Input, Output and FORMAT statements, Termination statements, GO TO, computed GO TO, Arithmetic IF and Logical IF statements, Type statement, Complex and logical variables, DOUBLE PRECISION variables, Subscripted variables, Dimension statement, DO statement, Statement function, FUNCTION and SUBROUTINE subprogram, EQUIVALENCE, COMMON and DATA statements. Fundamental concepts of operating systems, Booting process, file and directory concepts through DOS and Windows. Introduction to Word Processors; Creating and editing files in MS-Word, designing and formatting Word-documents; Introduction to spreadsheets, menus and capabilities of MS-Excel, using inbuilt mathematical and statistical functions in Excel, modification and editing of Excel work sheets, creating and editing graphs, introduction to macros-programming, data import and export; Introduction to DBMS, creating, retrieving and updating files, sorting, indexing and using multiple files, creating and printing reports under the Data Base package.

Practical: Operating system commands and exercises pertaining to the above mentioned packages.

Stat-505

METHOD OF APPLIED MATHEMATICS

2+1 Sem.II

Integral Transforms Fourier integral theorem and its various forms, Fourier transforms and elementary theorems, convolution theorem, inverse theorems for Fourier transform, Heaviside's unit step function; pulse and error function; Laplace transform and its properties; The complex inversion formula, convolution theorem for Laplace transforms; Application of Fourier and Laplace transform to boundary value problems and their applications as a tool to solve the mathematically converted industrial problems.

Integral Equations classification and origin of integral equations; Conversion of differential equations into integral equation Green's function; Fredholm and Volterra equations and their solutions by different methods; Approximate methods for solving nonlinear Fredholm and Volterra equations. Calculus of variation, functionals and their variation; Necessary conditions for extremum, Euler's equations, one and several independent variables; Variable boundary problem, problem with subsidiary conditions; Sufficient conditions for weak and strong extremum, Hamilton's principal, Lagrange's equation, variational problem for elastic plate, Rayleigh Ritz method; Sturm Liouville problem.

Practical: Solving problems based on the above topics.

Stat-506

REAL AND COMPLEX ANALYSIS

2+1 Sem.II

Metric spaces, open and closed sets, limit points. Sequences and series of functions, their pointwise and uniform convergence, continuity of the sum function, integration and differentiation of series of functions. Fourier series.

Riemann-Stieltjes integrals, existence and properties of the integral. Fundamental theorem of calculus. Functions of bounded variation, first and second mean value theorems, convergence and uniform convergence of improper integrals.

Topology of the complex plane. Stereographic projections. Limits, continuity and differentiability of complex functions. Analytic functions, Cauchy-reimann equations. Contour integrals. Cauchy integral theorem and Cauchy integral formulae. Taylor's series. The maximum modulus principle.

Laurent series, classification of singularities, Residue theorem, its application to evaluation of contour and improper integrals. Elementary conformal maps, bilinear transformations, Schwarz-christoffel transformation.

Practical:Solving problems based on above topics.

Stat-502 STATISTICAL INFERENCE -I 4+0 Sem.II

(Pre-requisite: Stat-501)

Point estimation, methods of moments, maximum likelihood and minimum chi-square; Criteria of good estimator, sufficiency, completeness and uniqueness; Camer-rao inequality, Rao-Blackwell theorem, uniformly minimum variance unbiased estimator; Interval estimation, confidence intervals for means, difference of means and variances; Types of hypotheses, testing of hypotheses, type-I and type-II errors, critical regions, power of a test; Neyman-Pearson lemma, likelihood ratio test and its applications; Sequential analysis, SPRT, ASN and OC curve; Non-parametric methods, types of non-parametric hypotheses, Sign test, Rank test and Wilcoxon test, Run test, Median test, Mann Whitney test.

Stat-503 INDUSTRIAL AND VITAL STATISTICS 3+0 Sem.II

Control charts for variables and attributes (X-chart, R-chart, ?-chart, P-chart, etc.); Sequential sampling plan for attributes inspection; reliability function, hazard function, reliability of series and parallel systems, reliability problems in life and testing models for censored and complete sample for exponential distributions; Crude death rate, specific death rate, standardized death rate, infant mortality rate, neonatal and maternal mortality rate, crude firth rate, general fertility rte, age-specific fertility rate, total fertility rate, standardized fertility rate, incidence rate, prevalence rate, case fatality ratio, immaturity ratio, complete and abridged life tables, construction of life tables from vital statistics.

Stat-504 APPLIED LINEAR MODELS 3+0 Sem.II

Linear regression, partial F-tests and sequential F-tests; Testing a general linear hypothesis in regression models, weighted least squares, bias in regression estimates, study of residuals, orthogonal polynomials, selection of best regression equation, multiple regression applied to analysis of variance; Model-types and assumptions, non-orthogonal analysis with unequal numbers, multiple and nested classifications; Non-linear regression analysis with different methods.

Stat-505 DESIGN OF EXPERIMENTS-I 31 Sem.II

Linear estimation and tests of linear statistical hypothesis; Basic principles of designs, basic designs – CRD, RBD, LSD, Graeco Latin square designs and their analysis; analysis of non-orthogonal data, co-variance technique and missing plot techniques; Incomplete block designs, C-matix and its properties, concept of connectedness, orthogonality, balanced and partially balanced incomplete block designs, analysis of block designs, various optimal criteria, BIBD-resolvability, parametric relations, inter and intra block analysis of BIBD; Factorial experiments and confounding; Split and strip plot designs; Trials at cultivator's fields and switch over designs; Analysis of group of experiments and long term experiments.

Practical:Analysis of data based on above designs.

Stat-506	DESIGN OF EXPERIMENTS-II (Pre-requisite: Stat-505) Construction of sets of MOLS and BIB designs; Concept of association schemes, standard PBIB designs and their analysis; Lattice and Youden square designs; Confounding in symmetrical and asymmetrical factorial experiments, fractional replications; Response surface and second order rotatable designs.	3+0	Sem.I
Stat-507	THEORY OF SAMPLING TECHNIQUES AND DESIGNS OF SURVEYS-I Concept of sample surveys and its advantages; Principal steps in sample surveys, simple random sampling with and without replacement, sampling for proportions, stratified sampling, sample allocations, probability proportional to size (PPS) sampling, cluster sampling with equal and unequal cluster sizes, systematic sampling, multistage and multiphase sampling; Ratio.	31	Sem.II
IMI-507	DISCRETE MATHEMATICS Logic and connectives propositions, Complex propositions, Truth tables, Tautologies, contradictions, Arguments and proofs. Relations and Functions Relations, Digraphs, Matrix of a relation, Properties of relations, Equivalence and partial order relations, Operations on relations paths and closures. Functions, types of functions, identity and invertible functions. Recursion and Recurrence relation Polynomial and their evaluation, recursion, induction, interaction, sequences and discrete functions, recurrence relations and generating functions. Boolean Algebra and Combinatorial circuits Lattices, sublattices, isomorphism of lattices, Boolean, algebra, Boolean expressions, application of Boolean algebra to circuit theory, circuit minimization and simplification. Monoids and Automata Definition and properties of monoids, isomorphism, free monoids, Grammars and their types, Languages, Finite state machines. Equivalent finite state machines, Monoid of a finite state machine and machine of a monoid. Practical: Solving problems based on the above topics.	2+1	Sem.II
IMI-508/ COMP-503	PROGRAMMING THROUGH 'C' Basic concepts of data structures, Types of files and their organization; Introduction to sorting and searching techniques; Introduction to programming languages, compilers, interpreters and system utilities, debugging and programming errors. 'C' language: Brief historical introduction, essential features of 'C'; constants and variables, Character set and data types in 'C'; Arithmetic, relational, Logical, Assignment and Bitwise Operators and Expressions in 'C', Decision making and Branching; FOR, WHILE and DO Statements; Arrays and initialization, higher dimensional arrays and matrices functions; Character test; Recursive functions and user-defined functions; structures and character strings; Pointers and their uses in structures; Dealing mixed data and printing and formatted outputs.	2+1	Sem.II

Practical:Developing programmes for mathematical and statistical problems.

IMI-509	APPLIED FUNCTIONAL ANALYSIS	2+1	Sem.I
	<p>The concept of metric space, Normed linear space, Banach space, Inner product space, Hilbert space and examples.</p> <p>Linear transformations and Linear operators, Norm of operators, Space of bounded linear transformation, Linear functional's, Dual spaces, riesz representation theorem.</p> <p>Adjoint operators in Hilbert and Banach spaces, Self adjoint operators, Positive definite operators, Projection operators. Fixed point theorems and their applications, Best approximations in Hilbert spaces, Gatean and Frechet derivatives, Solution of boundary value problems, optimizations problems, Applications to integral and differential equations.</p> <p>Practical:Solving problems based on the above topic.</p>		
IMI-510	MATHEMATICAL MODELLING	2+1	Sem.I
	<p>Introduction to mathematical modeling, type of models. Frame work of modeling with a simple case study. Modelling through first order differential equations. Growth and decay models, drug absorption models, rocket flight, electric circuit, economic growth, spread of epidemics, linear second order differential equation, mechanical oscillations, electric circuits, non-linear equations, planetary motion difference equation, Signal processing, economics and finance models, models in genetics, partial differential equation – traffic control, some diffusion models.</p> <p>Practical:Solving problems based on the above topics.</p>		
IMI-511	OPERATIONS RESEARCH	2+1	Sem.I
	<p>Definitions and scope of operations research, different types of models and their construction. Linear programming, Convex sets, Graphical method, Simplex method, revised simplex method, Duality theory, Dual simplex method, Sensitivity analysis, Multi-objective and goal programming (Solutions using graphical and simplex methods).</p> <p>Integer programming cutting plane and branch and bound techniques for all integer and mixed integer programming; Algorithms for 0-1, traveling salesman and cargo loading problems. Transportation, transportation with transshipment, allocation and assignment problems. Sequencing and scheduling processing of jobs through machines, CMP AND PERT. Game theory: Pure and mixed strategies, solution by graphical method and by linear programming.</p>		
IMI-512/ COMP-504	SCIENTIFIC DATA PROCESSING	1+2	Sem.I
	<p>Introduction to statistical package (SPSS/SAS), data transformation and statistical analysis through SPSS/SAS, editing and printing of SPSS/SAS outputs; Introduction to a mathematical software (Matlab/Maple/MathCAD/Mathematika); solving liner and non-linear simultaneous equations, matrices, differential equations, partial differential equations, transdental equations etc; Monte-Carlo simulation and Graphs (2D & 3D).</p> <p>System analysis and system design; System development life cycle; Introduction to information systems and their types; Principles, design and characteristics of management information systems; Developing an information system.</p> <p>Practical:Extensive practice on the above packages.</p>		

IMI-513	APPROXIMATION THEORY	2+1	Sem.II
	<p>Concept of best approximation in a normed linear space, existence of best approximation, uniqueness problem, convexity-uniform, strict and their relations, continuity of best approximation operator. Weierstrass theorem, Bernstein & Modified Bernstein polynomials, Montone operators, Korovkin's theorems. Lipschitz class, modulus of continuity and integral modulus of continuity their properties. Bernstin inequality, Jackson theorem and its converse; Saturation theorems, linear combination of positive linear operators, Sobolev space, cubic Spline interpolation.</p> <p>Practical:Solving problems based on the above topics.</p>		
IMI-514	SOME TOPICS IN INFORMATION THEORY	2+1	Sem.II
	<p>Shannon's entropy and its properties, generalized entropies; Noiseless coding; uniquely decipherable and instaneous codes, Noiseless coding theorem, construction of optimal codes, the discrete memoryless channel; entropy optimization principles and their applications, concept of distance in probability space; kullback's cross-entropy principle and applications.</p> <p>Practical:Solving problems based on the above topics.</p>		
IMI-515	OPTIMIZATION TECHNIQUES	2+1	Sem.II
	<p>Non-linear programming convex functions, convex non-linear programming, convex quadratic programming, Kuhn Tucker Theory, separatable programming.</p> <p>Geometric programming problems with positive and negative coefficients, degree of difficulty. Dynamic programming discrete and continuous cases, Forward and Backward recursive formulae cargo loading, capital budgeting and reliability problems. Search techniques direct search and gradient methods, Unimodal functions, Fibonacci method, Golden section method, method of steepbest descent, Newton-Raphson method, Hook's and Jeeve's method, Conjugate gradient methods.</p> <p>Queueing models analysis of simple queues with poisson arrival and exponential service time distributions.</p> <p>Inventory models economic order-quantity, Dynamic and stochastic inventory models.</p> <p>Practical:Solving problems based on the above topics.</p>		
IMI-516	ROBOTICS AND CONTROL	2+1	Sem.II
	<p>Introduction Robotics, Robot manipulator, applications, simple planar model, Robbot specifications. Homogenous transformation: Translation and rotation matrices, link coordinate frames, change of frames and relative transformation, general translation and rotation transformation. Kinematic equations Euler a nangles, roll, pitch, Yaw, Cylindrical and spherical coordinates, the Arm equation. Differential relationships derivatives of transformations, velocity and acceleration, The Jacobian and inverse Jacobian, inverses kinematic problems.</p> <p>Dynamics and control Lagrangian Mechanics, Dynamic equations, control of manipulator dynamics, trajectory planning, motion and grasp planning, Robotic vision. Some examples and simulations.</p> <p>Practical:Solving problems based on the above topics.</p>		
IMI-517	QUEUES AND RELIABILITY	2+1	Sem.II

Review of topics from the theory of probability and stochastic processes; Random variables, Bernoulli, Binomial, Geometric, Multinomial exponential, Poisson, K-erlang Distributions, probability generating functions, classification of stochastic processes, Markov-chains, Birth-death processes, Statistical equilibrium.

Birth-queuing models in equilibrium. Time-dependent behaviour of M/M/1 and linear birth-death queuing models. Imbedded Markov-Chain technique and M/G/1 queuing model in equilibrium: Distribution of number in system, Distribution of waiting time, The busy period and its distribution, Derivation of special queuing models such as M/E/1, etc. Time dependent behaviour of M/G/1 queuing model by supplementary variable technique. Network of Markovian queues. Concepts and definition of reliability, The derivation of reliability functions. Reliability models of non-maintained systems. System maintenance policies. Reliability modeling in non-Markotian.

Practical:Solving problems based on the above topics.

**IMI-518/
STAT-517**

PROBABILITY THEORY AND STATISTICAL METHODS 2+1 Sem.II

Probability, random variable, theoretical expectation, variance, moments, median and quartiles, Distributions –Binomial, Poisson, Hypergeometric, Normal, Exponential, gamma, Beta, Weibull Lognormal. Law of large numbers, Central limit theorem (no theoretical results, but as applications). Independence of random variables, correlation coefficient, Linear regression (Method of least squares).

Sampling, sampling distributions – normal, t, and F. Estimation, standard error, test of significance, tests for samples from normal population. Analysis of variance, one way and two way classification (no theoretical results but applications). Introduction to quality control.

Practical:Solving problems based on the above topics.

COMPUTER SECTION

UG AND PG COURSES

COMP-101 INTRODUCTORY COMPUTER SCIENCE 1+1 Sem.I&II

Introduction to Computers, Evolution of Computers, Characteristics, Classification, Functions of Computers, Data representation.

Computer hardware – Central Processing Unit, Input/Out Devices, Microprocessors (Fundamentals)

Computer Software – Operating systems, Application softwares like Word Processors (Word Star/Word Perfect/MS-Word) and Spread-sheets (LOTUS 1-2-3/MS-Excel)

Practical:Practical exercises pertaining to above theory contents.

**COMP-501/
Stat-509 COMPUTER PROGRAMMING IN STATISTICAL RESEARCH 2+1 Sem.I**

Introduction to Computers, Types of Computers, Computer generations and classifications, Computer peripherals, Memory units, Control units, Arithmetic and Logic unit, Secondary storage.

Computer codes – Arithmetic Binary system, Octal and Hexadecimal number system, Conversion to decimal system.

Computer softwares – Machine language, Assembly language, high level language, Compilers, Interpreters and System utilities, Flowcharting and programming, Debugging, testing and Types of errors.

Formulation of Algorithm, Elements of FORTRAN language, constants and variables, Operations and symbols, Expressions, Common mathematical functions, Arithmetic assignment statement, Input, Output and FORMAT statements, termination statements, GO TO, computed GO TO, Arithmetic IF and Logical IF statements, Type statement, Complex and Logical variables, DOUBLE PRECISION variables, Subscripted variables, Dimension statement, DO statement, Statement function; FUNCTION and SUBROUTINE subprogram, EQUIVALENCE, COMMON and DATA statements.

Practical:Development of computer programs in FORTRAN for the measures of central tendency, measures of dispersion, correlation and regression, simple testing of significance and analysis of CRD and RBD.

COMP-502/ **COMPUTER FUNDAMENTALS** **1+2** **Sem.I**
IMI-504

Introduction to computer organization, computer generations, input-output units; computer memory system; system and application softwares; Fundamental concepts of operating systems, Booting process, file and directory concepts through DOS and Windows. Introduction to Word Processors; Creating and editing files in MS Word, designing and formatting Word-documents; Introduction to spreadsheets, menus and capabilities of MS-Excel, using inbuilt mathematical and statistical functions in Excel, modification and editing of Excel work sheets, creating and editing graphs, introduction to macros-programming, data import and export; Introduction to DBMS, creating, retrieving and updating files, sorting, indexing and using multiple files, creating and printing reports under the Data base package.

Practical:Operating system commands and exercises pertaining to the above mentioned packages.

Stat-591 **SEMINAR** **0+1** **Sem-I&II**
Stat-600 **MASTER'S RESEARCH**
Stat-700 **DOCTORAL RESEARCH**

DEPARTMENT OF MICROBIOLOGY

Field of Specialisation for: Soil Microbiology, Industrial Microbiology, Microbial
M.Sc. & Ph.D: Physiology, Food Microbiology, Environmental
Microbiology, Molecular Microbiology.

Required Courses:

M.Sc. Micro-501, Micro-502, Micro-503, Micro-504, Micro-505, Micro-506, Micro 591.
Ph.D Micro-601, Micro-602, Micro-603, Micro-604 and Micro-591

Courses open to M.Sc./ Ph.D student of other Colleges/Department for Minor credits only:

M.Sc.- Micro-400 and Micro-500 series

Ph.D.- Micro-500 and Micro-600 series

Ph.D. students who have not done M.Sc. (Microbiology) will be required to take 500 series courses required for M.Sc. if not taken earlier.

UNDERGRADUATE COURSES

Micro-101 ELEMENTARY MICROBIOLOGY 2+1 Sem I

Introduction and Scope of Microbiology, Historical Development. Prokaryotes-Morphology, Structure and Function; Classification of prokaryotes; Salient characteristics of some important groups of bacteria. Viruses-Morphology, general characteristics, life cycle and classification of bacterial viruses. Growth and death of bacteria; growth curve. Role of microorganisms in organic matter decomposition and bioconversions. Microbiology of Nitrogen, Phosphorus and Sulphur transformation; Dinitrogen fixation and role of microorganisms in maintenance of soil fertility; Mycorrhizae and phosphate solubilization. Biofertilizers, Biogas and Composting. Role of microorganisms in the control of pests; Biopesticides. Industrial uses of microorganisms. Microorganisms associated with different foods; Preservation of foods; Food spoilage and food poisoning. Microbial interactions. Microbiology of Air, Water and Soil.

Practical: Examination of different types of microorganisms/ Simple staining. Gram staining. Capsule staining. Spore staining and Negative staining. Preparation of media and sterilization techniques. Methods of isolation of bacteria. Demonstration of ubiquitous presence of microbes. Isolation of root nodule bacteria.

Micro 102 ELEMENTARY FOOD AND DAIRY MICROBIOLOGY 1+1 Sem II

Introduction to microbiology. Brief discussion on bacteria, fungi and viruses. Nutrition and growth of microorganisms. Role of microorganisms in food spoilage and their control. Microbiology of meat, egg, fruits, vegetables, milk and milk products. Food poisoning. Brief discussion on some industrially important microorganisms. Quality control aspects.

Practical: Study of microscope and other laboratory equipments. Examination of bacteria, yeast and molds. Sterilization techniques. Preparation of culture media. Methods of testing sterility of utensils. Enumeration of microorganisms from various food materials.

Micro 401 INTRODUCTION TO MICROBIOLOGY 2+1 Sem I

Microbiology and its importance; Role of microorganisms as producers, consumers and degraders. Historical developments in microbiology and allied disciplines. Prokaryotes – morphology, structure and function of microbial cell and their components. Classification of prokaryotes. Important groups of bacteria. Eucaryotic cell- structure and function. Major groups of Fungi, Algae and Protozoa. Viruses – general characteristics, morphology and classification of plant, animal and bacterial viruses. Physical and chemical methods of control of microorganisms. Role of microorganisms in agriculture, food and biotechnology. Role of microorganisms and food spoilage. Food fermentations and principles of food preservation.

Practical: Microscopic examination of microorganisms. Stains and staining techniques-simple, Gram, spore, capsule, flagella and negative staining. Preparation of media and methods of sterilization, Isolation, purification and

maintenance of microorganisms. Microbiological examination of water and milk.

Micro 402 APPLIED MICROBIOLOGY 2+1 Sem II

Importance of bacteria, yeast, molds and actinomycetes in food and industry. Types of fermentation systems. Large scale cultivation of microorganisms for the production of microbial products, Microbiology of water and sewage treatment. Microbiology of air and control of microbes in air. Microbiology of food spoilage and preservation.

Practical: Laboratory scale fermentation using bacteria and yeasts. Microbiological examination of food, water, milk and sewage.

Micro 403 PRINCIPLES OF FOOD AND DAIRY MICROBIOLOGY 2+1 Sem II

General aspects of food and microorganism important in food and dairy products; Conditions influencing growth of microorganisms in foods. Determination of microorganisms and their products in foods. Microbiology of fermented foods. Spoilage of different foods. Food borne infections and intoxications. Indicator organisms. Useful microorganisms in food. Principles of food preservation.

Practical: General instructions for sampling of food and microbiological analysis; Testing of sources of contamination of food; Microbiological analysis of various foods; Enumeration of spore forming bacteria, coliforms and thermophilic bacteria in food samples. Preservation of foods by chemical agents.

Micro 404 INTRODUCTORY SOIL MICROBIOLOGY 2+1 Sem I

History of soil microbiology; Groups of microbes in soil; Soil environment and microflora; Cycling of N, P, S and micronutrients in soil. Decomposition and humus formation; Rhizosphere microflora and role of microbes in crop productivity. Microbial transformation of xenobiotics.

Practical: Enumeration of various groups of soil microorganisms. Demonstration of rhizosphere effect, soil respiratory activity, nitrification, denitrification and measurement of N₂ fixation.

POSTGRADUATE COURSES

Micro-501 PRINCIPLES OF MICROBIOLOGY 3+1 Sem I

Development of microbiology in the 18th and 19th century. Morphology, structure and function of prokaryotic and eucaryotic cell. Classification of prokaryotes – Basic principles and techniques used in bacterial classification; Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and rRNA sequencing in classifications. Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tenericutes and Mendosicutes. Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; Some common bacterial and viral diseases of man and animals.

Practical: Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food). Enrichment culture technique – Isolation of symbiotic, symbiotic nitrogen fixing bacteria. Winogradsky column and isolation of photosynthetic bacteria. Use of selective media. Antibiotic resistance and isolation of antibiotic producing microorganisms. Morphological, physiological and biochemical characterization of bacteria.

Micro-502	MICROBIAL PHYSIOLOGY AND METABOLISM (Pre-requisite Micro-401/501)	3+1 Sem II
	Structure, function, biosynthesis and assembly of various cellular components of prokaryotes. Transport of solutes across the membrane. Microbial growth. Cell cycle and cell division. Effect of chemicals and other environmental factors on growth. Morphogenesis and cellular differentiation. Important metabolic patterns in photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs.	
	Practical: Use of simple technique in laboratory (Colorimetry, Centrifugation, Electrophoresis and GLC). Determination of viable and total number of cells. Measurement of cell size. Gross cellular composition of microbial cell. Growth – Factors affecting growth. Sporulation and spore germination in bacteria. Protoplasts formation. Induction and repression of enzymes.	
Micro-503	BACTERIAL AND VIRAL GENETICS (Pre-requisite Micro 401/501)	2+1 Sem I
	Prokaryotic, Eucaryotic and Viral genome. Replication of Eucaryotic, Prokaryotic and Viral DNA. Structure, classification and replication of Plasmids. Molecular basis of mutation. Biochemical genetic and gene mapping by recombination and complementation. Fine gene structure analysis. Fungal genetics. Gene transfer in bacteria through transduction, transformation and conjugation and gene mapping by these processes. Transposable elements. Gene cloning and gene sequencing. Impact of gene cloning on human welfare. Regulation of gene expression.	
	Practical: Inactivation of microorganisms by different mutagens. Production, isolation and characterization of mutants. Determination of mutation rate. Isolation, characterization and curing of plasmids. Transfer of plasmid by conjugation, electroporation. Tetrad and random spore analysis.	
Micro-504/ Soil 508	SOIL MICROBIOLOGY	2+1 Sem I
	Ecology of soil microbes; Components of soil biota; Soil microbial biomass; Distribution of microorganisms in soil and interaction with environment; Organic matter decomposition; Nature and properties of formation of humic substances; Ammonification, nitrification, denitrification; Environmental impacts of N cycle; Biological N ₂ fixation and biofertilizers; Rhizosphere biology; Phosphorus transformation and mycorrhizal symbiosis; Sulphur transformation and role of sulphur oxidizing bacteria in soil fertility; Transformation of Fe and other micronutrients; Pollution and soil microbial processes.	
	Practical: Assessment of soil microbial population; Soil microbial biomass; Decomposition studies in soil, Soil enzymes; Measurement of important soil microbial processes such as ammonification, nitrification. N ₂ fixation, S oxidation, P solubilization and mineralization of other micro nutrients; Study of rhizosphere effect.	
Micro-505/ Biotech 508	MICROBIAL BIOTECHNOLOGY (Pre-requisite Micro 401/402/501)	2+1 Sem II
	Introduction, scope and historical development; Isolation, Screening and genetic improvement of industrially important microorganisms; Type of fermentation systems; production of various primary and secondary metabolites, e.g. amino acids, organic acids, alcohols, enzymes, organic solvents, antibiotics etc.; Down stream processing; Over-production of	

metabolites; Bioreactor operations, process control; Fermented beverages; Production of single cell protein; Steroid transformation; Immobilization of cells/enzymes, silage production; Waste water treatment; Use of genetically engineered microorganisms in biotechnology; Bioinsecticides, biofertilizers, etc. Food colours and flavours. Retting of flax.

Practical : Isolation of industrially important microorganisms, their maintenance and improvement. Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery; Study of bio-reactors and their operation: Production of biofertilizers.

Micro-506

FOOD MICROBIOLOGY

2+1 Sem II

(Pre-requisite Micro 401/403/501)

Introduction and scope; Food Microbiology – A many faceted science; Interrelationship of food microbiology with other sciences; Perspectives on food safety and Food Biotechnology. Factors of special significance in Food Microbiology – Principles influencing microbial growth in foods; Spores and their significance; Indicator organisms and Microbiological criteria; Microbial spoilage of foods- meat, milk, fruits, vegetables and their products; Food poisoning and food borne pathogenic bacteria. Food fermentation; Fermented dairy, vegetable, meat products; Preservatives and preservation methods – physical methods, chemical preservatives and natural antimicrobial compounds. Bacteriocins and their applications; Biologically based preservation systems and probiotic bacteria. Advanced techniques in detecting food borne pathogens and toxins. Hurdle technology and Hazard analysis. Critical control point systems in controlling microbiological hazards in foods

Practical: Statutory, recommended and supplementary tests for microbiological analysis of various foods : Baby foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers and water.

Micro-507

BACTERIAL VIRUSES

1+1 Sem II

Historical developments and classification of bacteriophages. Physiology, biochemistry, enzymology and biology of phage-bacterial interactions. Structure, functions and life cycles of different DNA, RNA, lytic and lysogenic phages. Phages in the development of molecular biology and genetic engineering.

Practical : Titration of phages and bacteria. Absorption of phages. Preparation of phage stocks. Isolation of new phages and phage resistant bacteria. One step growth curve, phage bursts. Induction of lambda. Complementation of T₄ rII mutants etc.

Micro-508

ENVIRONMENTAL MICROBIOLOGY

1+1 Sem I

(Pre-requisite Micro-502)

Scope of environmental microbiology. An overview of microbial niches in global environment and microbial activities. Microbiology of air, outdoor and indoor environment in relation to human, animal and plant health and economic activities. Microbiology of natural waters. Environmental pollution – Deleterious and beneficial role of microorganisms. Environmental microbiology in public health. Microbial technology in pollution abatement, waste management and resource recovery in metal, petroleum and bioenergy fields. Microbial upgradation of fossils fuels and coal gas. Microbial interaction in rumen and gastrointestinal tract. Biodeterioration.

Practical : Analysis of natural waters, waste waters and organic waste in relation to water pollution assessment, pollution strength and resource quantification; Quality control tests, waste treatment and anaerobic digestion; Demonstration of waste water treatment processes such as activated sludge processes, biofilter and fluidized bed process.

Micro-601	ADVANCES IN FERMENTATION	3+0	Sem I
	<p>An overview of fermentation - current status of fermentation industry. Fermenter design, high performance bioreactors, mass and energy transfer in bioreactors. Instrumentation and control in fermenters – on line measurement systems, computer application; Media for microbial fermentation; Criteria in media formulation. An overview of downstream processing, New strategies for isolation of industrially important microbes and their genetic manipulations; Microbial production of health care products. Antibiotic fermentation research; steroid transformation; Recent developments on production of primary and secondary metabolites, Treatment of biological wastes, microbial inoculants and enzymes for waste treatment yeast technology – classification, genetics, strain improvement for brewing, baking and distilleries and topics of current interest in fermentations.</p>		
Micro-602	ADVANCED MICROBIAL PHYSIOLOGY (Pre-requisite Micro-502)	3+0	Sem I
	<p>Origin, evolution, structure, function and molecular aspects of various cell components. Differentiation in bacteria, slime molds, yeasts. Molecular biology of bioluminescence, bacterial virulence. Heat shock response. Extracellular protein secretion in bacteria and topics of current interest in molecular microbiology.</p>		
Micro-603	REGULATION OF MICROBIAL BIOSYNTHESIS (Pre-requisite Micro-502/503)	3+0	Sem II
	<p>Regulation of initiation, termination and antitermination of transcription. Global regulation and differentiation by sigma factor. Regulatory controls in bacteria-inducible and biosynthetic pathways. Ribosomal RNA and ribosomal proteins regulation under stress condition. Specific regulatory systems; SOS regulatory control; Antisense-RNA regulation of gene expression. Oxidative stress control. Fermentative and respiratory regulatory pathways. Regulation of cell cycle. Lytic and lysogenic cascade. Global nitrogen control and regulation of nitrogen fixation and other recent topics of regulatory systems of current interest.</p>		
Micro-604	CURRENT TOPICS IN SOIL MICROBIOLOGY (Pre-requisite Micro-504)	3+0	Sem II
	<p>Molecular ecology and biodiversity of soil microorganisms; Survival and dispersal of microorganisms; Microbial successions and transformation of organic matter; Role of microorganisms in soil fertility; Bioremediation of polluted soils; Biological control and other topics of current interest.</p>		
Micro-591	SEMINAR	1+0	Sem I/ II
Micro -600	MASTER'S RESEARCH		
Micro -700	Ph.D. RESEARCH		

DEPARTMENT OF SOCIOLOGY

Field of Specialization for M.Sc. and Ph.D.	:	Rural Sociology, Rural Development and Sociology
Required Courses M.Sc.	:	Soc. 501, Soc. 502, Soc. 503, Soc. 504, Soc. 591
Ph.D.	:	Soc. 601, Soc. 604, Soc. 591
Courses open to M.Sc. students of other Colleges/Departments for Minor credits only	:	Soc. 401, Soc. 402, Soc. 504, Soc. 505, Soc. 506, Soc. 507, Soc. 508, Soc. 509 and Soc. 510
Deficiency courses for those joining without elective optional Sociology	:	Soc. 401 and Soc. 402

UNDERGRADUATE COURSES

Soc-101 RURAL SOCIOLOGY AND HUMAN PSYCHOLOGY 3+1 Sem I

Sociology and Rural Sociology meaning, Nature, Importance and scope. Relationship of Rural Sociology with other Social Science and Home Science. Understanding Basic Sociological concepts - Society, community, association, institution, social groups. Rural Social structure-family, caste, class, kinship. Characteristics of rural and tribal society - rural urban differences. Problems of Rural Society. Culture - Meaning, Importance, cultural components-norms, customs, mores, folkways. Social change - meaning and importance. Social control - meaning, importance and ways of social control. Elements of social system. Origin and development of psychology. Branches and methods of psychology. Biological basis of behaviour - nervous system and glandular system.

Practical : Folklore of Haryana, their nature, type, meaning and importance. Exercise in experimental psychology.

Soc-102 RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY 2+0 Sem I

Nature and scope of sociology and rural sociology and their relationship with other social sciences; origin, development and importance of the study of rural sociology: basic concepts of sociology and their application to rural life; concept of human society; characteristics of rural community; theory and principles of social structure; social interaction and processes; role of social, economic, political, educational and other institutions in rural society. Nature and meaning of psychology. Branches and methods of psychology. Meaning and definition of educational psychology. Aims and objectives of educational psychology. Motivation - meaning, motivation and drive. Function of motives in learning. Perception - meaning and characteristics of sensation and perception. Learning - characteristics and types of learning. Emotions - meaning, characteristics and importance of emotions. Personality - definition, characteristics and factors affecting personality.

Soc-103 SOCIOLOGY AND PRINCIPLES OF 2+1 Sem I
AHE-111 VETERINARY AND ANIMAL HUSBANDRY EXTENSION

Definition of Sociology, significance of study of rural and urban sociology for extension workers. Primary concepts of Sociology i.e. Society, Community,

Practical : Handing a group project for the analysis of social structure; formal and informal relationship; decision making channels and authorities for suggesting changes and outlines of community action programme in a given problem area; visit to social welfare and rural development institutions in India; visits to village and block level organisations, writing of report on visits.

POSTGRADUATE COURSES

Soc. 501	DEVELOPMENT OF SOCIAL THOUGHT	3+0	Sem I
	<p>Auguste Comte - Laws of three states; Hierarchy of sciences; Positivism and Social Statics and Social Dynamics. Herbert Spencer - Organic Analogy; Evolution, Individual and the State. Karl Marx-Historical Materialism; Class and Class Struggle; Alienation. Emile Durkheim-Social Fact; Division of Labour; Sociology of Religion; Suicide. Max Weber - Verstehen (Understanding), Ideal type, Social Action: Types, Protestant Ethic and Capitalism; Types of Authority. Vilfredo Pareto-Logical and Non-logical Action; Circulation of Elites.</p>		
Soc-502	CONTEMPORARY SOCIOLOGICAL THEORIES	3+0	Sem.II
	<p>Functionalism: Origin and Basic Postulates of Functionalism: Functional prerequisite of a Social system; Functional problems of a social system; Manifest and latent functions; Dyafunctions and Major Critiques of Functionalism as theory as ideology. Conflict Theory : Contribution to the conflict theory; Marxist theory; Simmel; Lewis Coser; Max Gluckman and Ralk Dahrendorf. Symbolic Interactionism: Contributions of Cooley; Mead; Blumer; Kuhn; and Goffman. Phenomenology and Ethanomethodology: Contributions of Karl Mannheim; Alfred Shutz, Peter Berger and T. Luckman, Harold Garfinkel. Similarities and Dissimilarities between Ethnomethodology and Phenomenology. Social Exchange Theory: Contributions of George Homans and Peter Blau. Structuralism: Contributions of Radcliffe-Brown, S.P. Nadel, and Levi-Strauss. Recent Attempts to synthesize structuralist and Marxian perspective. Sociology of knowledge; Contributions of K. Marx/M. Mannheim.</p>		
Soc-503	RESEARCH METHODS IN SOCIAL SCIENCES	2+1	Sem.II
	<p>Logic of the sciences and humanities; scientific method and its application in the analysis of social and cultural phenomena; types of social research. Basic elements of scientific methods: fact, concept, hypothesis, theory. Research Design; Action Research; Sampling; measurement and its levels; methods of data collection: observation; interviewing; questionnaire and schedules; case study method; content analysis; sociometric measurements of attitude, opinion and achievement; validity and reliability procedures in quantification, analysis, interpretation. Statistics and its use in social research and report writing.</p> <p>Practical : Students will have to undertake field surveys and submit project reports.</p>		
Soc-504	RURAL SOCIOLOGY AND RURAL SOCIAL STRUCTURE	4+0	Sem.I
	<p>Definitions, nature and scope of rural Sociology. Importance of the study of Rural Sociology. Rural and urban differences. Rural-urban continuum. Demographic and ecological characteristics of rural area. Rural Social Structure; Caste Structure in rural set up; Inter-caste relations - Jajmani system; Caste and Politics; Changing trends of caste structure. Rural Economy: Land ownership pattern, Agriculture and animal husbandry. Rural</p>		

Industries, Land reforms and its effect, Green Revolution and its impact. Rural Religion: Role of religion in rural life. Family and Marriage: Rural family and its role, Mate selections and marriage, Changes in family and marriage. Rural Political System: Caste and Caste Panchayat and its role in the power structure, Gram Panchayat, Panchayat Samiti and Zila Parishad, its constitution, powers and functions. Emerging pattern of rural leadership. Rural Problems: Rural poverty and indebtedness, Problems of landless agricultural labourers. Unemployment and Under-employment, Rural housing, Rural health, Illiteracy and ignorance. Measures undertaken to solve the problems. Rural Development Programmes : Programmes implemented before independence, Programmes undertaken after independence, Evaluation of various programmes, especially I.R.D.P. Rural Social Change: Factors of Social Change, Changing Scene.

Soc-505 DYNAMICS OF SOCIAL CHANGE 3+0 Sem.I

Social and cultural evolution; lag hypothesis; influential factors and consequences of social change; contemporary theories of social change including directed and planned social change; process of social change in India - Sanskritization, Westernization, urbanisation, etc.; planned change programmes; process and principles of diffusion and adoption of new ideas; social, economic and cultural factors influencing rate of adoption; Case studies of improved agricultural and animal husbandry practices; problems of human adjustment in changing culture and society.

Soc-506 HUMAN GROUPS, DECISION AND LEADERSHIP 3+0 Sem.II

Human groups, group analysis, characteristics, functions and forms of interaction of small groups; nature and types of leadership, role of leader in the community life; rural community organisation and social change; concept and theories of leadership training, basic patterns of leader-group relationship; and nature of decision making; elements, agencies and processes involved in decision making in rural society; decision making in community development and innovation adoption, decision making in social change and social policy.

Soc-507 SOCIAL ECOLOGY, DEMOGRAPHY AND ENVIRONMENT 3+0 Sem.I

Ecology and human ecology; ecological concepts, spatial distribution of population, village, city, region; stages of economic development such as collective economy, nomadic economy, village economy and town economy; ecological areas and processes such as migration and mobility; nature and problems of environment; environmental pollution and its sources; pattern of land use, its problems regarding environmental sources. Central demographic theories especially those concerning population growth, population distribution and density, sex, age and ethnic composition; demographic processes including fertility, mortality and migration and their influence on population; population projections; health education - its nature and problems, recent advances and challenges in health and population education.

Soc-508 IMPACT OF SCIENCE AND TECHNOLOGY ON 3+0 Sem.II
DEVELOPMENT

Science, technology and society; concept of innovation, dispersion, succession and convergence; nature, relationship and problems of technology and culture, dynamics of technology affecting agriculture, industry, family, communication. Cultural lag and problems of human adjustment and mental health, impact of technology on rural social life.

Soc-509 SOCIAL PSYCHOLOGY 3+0 Sem.II

Nature, scope, development and methods of social psychology. Relationship of social psychology with other sciences and utility of social psychology. Innate and acquired human behaviour. Instincts; meaning and characteristics, instincts and emotions. Attitudes and their measurement. Learning: factors responsible for learning and theories of learning. Perception-social perception and role of perception in social interaction. Leadership; functions, characteristics and kinds. Propaganda; psychological basis and techniques of propaganda. Prejudice, characteristics, types and factors involved in development of prejudice. Personality and culture: nature and their relationship. Nature, process, agencies and stages of socialization. Group dynamics and group behaviour; meaning, factors and characteristics. Nature, causes, prevention and reformation of juvenile delinquency.

Soc-510 SOCIETY IN INDIA 3+0 Sem.II

Indian Society: Unity in Diversity, Varnashrama System, Caste-features, functions and changing aspects, caste, class, casteism, marriage, family and kinship - tradition and change. Tribal, rural and urban society in India: Tribal society, geographical distribution of Tribes, Clan, totemism, Taboo, Witchcraft, Magic, Religion, Law and Polity; Technology and Economy, Tribal Development; Rural Society, Village Community - Tradition and Change, Rural Economy, Rural Power Structure: Panchayati Raj, Rural Development, Rural Urban Interactions. Urban Society; Urban Centres - Traditional and Modern, Urban Ecology and Demography, Urbanization and Urbanism, Urban Renewal - Urban Planning and Development, Urban Government. Nation-Building; Society and the State: Social Background of Indian Nationalism, Nation-building and its problems, Political parties and new elites, Problems of minorities. Underprivileged Sections in India: Women, Scheduled Castes, Scheduled Tribes, Other Backward groups, Role of Social Legislation.

Soc-601 SOCIOLOGICAL THEORIES OF TODAY 3+0 Sem. II

The nominalistic trends in contemporary sociology, theories of cultural system; theories of social system, taxonomy and changes in socio-cultural system, Recent trends in Sociological theories.

Soc-602 COMPARATIVE SOCIOLOGY 3+0 Sem. I

Evolution and development of various institutions of simple and advanced societies; their modes of social stratification and organising principles of social life; emergence of new institutional framework and their inter-relations.

Soc-603 ADVANCED ANALYTICAL SOCIAL PSYCHOLOGY 3+0 Sem.II

Human behaviour foundations; biogenic and sociogenic factors, Psychodynamics of behaviour. Freud's psychoanalysis, relation between Id, Ego and Super Ego. Topographical aspect of mind or personality. Theories of behaviour; Psychoanalytical theory of Freud, Individual psychology of Adler and Jung's analytical theory. Psychoneurosis and psychosis; Symptoms and causes, differences between psychoneurosis and psychosis. Defence mechanism; major and minor mental, mechanisms. Socialization; nature and process of socialization; socialization and human behaviour; agencies and stages of socialization. Relationship between the individual and society. Social groups; classification of social groups. Processes and forms of social

interaction and role of perception in social interaction. Collective behaviour, characteristics and kinds of mass behaviour.

Soc-604 SOCIOLOGY OF RURAL DEVELOPMENT 3+0 Sem. I

Critical evaluation of some of the recent works on rural sociology; rural and agricultural development and the farmers of the world; contribution of sociology, anthropology and psychology to the understanding of the rural society, change and development perspectives; planning and social action and rural social policy, social values and developmental change; social, spatial and economic limits of social change; social-psychological variables in planned development; formation and destruction of communities and rural development planning. Policy, planning and administration concerning development of rural areas, family, child, women and youth welfare service; evaluation of various programmes of rural development.

Soc-591 SEMINAR 1+0 Sem I/ II
Soc-600 MASTER'S RESEARCH
Soc-700 Ph.D. RESEARCH

DEPARTMENT OF ZOOLOGY AND AQUACULTURE

COURSES IN ZOOLOGY

Field of specialization Apidology, Rodentology, Vermiculture
For M.Sc. and Ph.D.

Required courses

M.Sc. Zoo.501, Zoo.502, Zoo.503, Zoo.504,
 Zoo.505, Zoo.591 and any one from
 Zoo.506 to Zoo.510
Ph.D. Zoo.601, Zoo.602, Zoo.591 and any one
 From Zoo.603 to Zoo.607.

Courses open to M.Sc. Any two from Zoo.501 to Zoo.505 and
Students of their college/ third if required any one from Zoo.506
Departments for minor to Zoo.510
Credits only.

UNDERGRADUATE COURSES

Zoo.101 INTRODUCTORY ZOOLOGY 2+1 Sem.I

(Deficiency course for B.Sc.(Ag.) and B.Sc. (H.S.)Non-medical
Nature and scope of Zoology; taxonomic, classification of Animal kingdom, Animal life-structure and function (tissues, and other body systems); Human reproduction, gamete formation and embryonic development upto gastrulation; Applications of biology-communicable diseases, immune responses, inherited and sex linked diseases; cancer, human population growth etc.
Practical: Classification and general features of different animal types, microscopic structure of mammalian tissues; preparation of temporary mounts of human and frog blood; study of some physiological functions.

Zoo.401 ANIMAL ANATOMY AND PHYSIOLOGY 3+1 Sem.I

(For Bioscience Elective)
External and internal anatomy of Paramecium, Plasmodium, Scypha, Obelia, Fasciola, Ascaris, Pheretima, grasshopper, Unio, starfish, frog and rabbit; adaptive radiations; physiology of digestion, blood circulation, respiration, excretion, muscles, nervous system and reproduction.
Practical: Study of compound tissues; dissection of Pheretima, grasshopper, frog and rabbit/rat; skeleton of frog and rabbit; demonstration of some physiological functions such as osmosis, buffer action, action of enzymes, measurement of respiratory rate, recording of heart beat; study of blood groups, haemoglobin etc.

Zoo.402 ANIMAL ECOLOGY AND EVOLUTION 3+1 Sem.II

Biotic and abiotic factors; properties of terrestrial and aquatic ecosystems; principles of wild life conservation; means of evolution; evolution of man.
Practical: Measurement of ecological parameters; methods to study ecosystem; exhibition of films on wild life.

POST GRADUATE COURSES

Zoo.501 COMPARATIVE ANIMAL ANATOMY 3+1 Sem.I

Comparative functional anatomy of invertebrates and vertebrates with special reference to modifications of basic structural plan of various organ systems,

support and coordination (integumentary, skeletal, muscular and nervous systems including sense organs and endocrine glands), transport and exchange (alimentary, circulatory, respiratory and excretory systems) and reproduction, the aerodynamics in relation to flight in insects/birds and mammals.

Practical: Dissection and study of the representative types from invertebrates and vertebrates; preparations of whole mounts with reference to the systems in theory; study of histological slides; collection and identification of fauna.

Zoo.502 TAXONOMY AND SYSTEMATICS OF ANIMALS 2+1 Sem.I

General introduction, taxonomy and nomenclature, taxonomic categories and hierarchy, principles and methods of nomenclature; keys, their kinds and use; introduction to numerical, biochemical and cytological taxonomy. Classification of non-chordates and chordates upto orders and important families with distinguishing characters and examples.

Practical: Collection and preservation of certain animals; study of local fauna and their identification; identification of animals using keys; taxonomy of animals based on biochemical on cytological techniques.

Zoo.503 ENVIRONMENTAL BIOLOGY AND WILDLIFE CONSERVATION 2+1 SEM.1

Principles and concepts of an ecosystem; bioenergetics and productivity; biogeochemical cycles; limiting factors; organization of population and communities; ecological succession; environmental pollution-concepts and types; wildlife-concepts and significance.

Practical : Introduction to the ecological equipments, measurement of ecological parameters, productivity, population density, and species diversity in different ecosystems; determination of ID50 and LC50 values; visit to zoo/sanctuary or other habitats.

Zoo.504 ANIMAL PHYSIOLOGY AND BEHAVIOUR 3+1 Sem.I

Physiology of nutrition, thermoregulation, cellular immunity, neural; humoral and pharmacological regulation of cardio-vascular activities; neural integration, interneural communication; importance of specialized nerve cells; physiology of endocrine glands, hormonal receptors; physiology of reproduction and hormonal control of reproductive behaviour; origin and evolution of behaviour, instinctiveness, modes of biological communication significance of biorhythms.

Practical: Some biochemical estimations, buffer systems; demonstration of some hormonal functions; recording of action potentials; kymographic study of muscle contractions and heart beat; study of some behavioural aspects such as instinctive movements, orientation responses; maze learning in rats and activity rhythms in animals.

Zoo.505 METHODOLOGY AND DEVELOPMENTAL BIOLOGY 2+2 Sem.II

Brief introduction to microtomic/ultramicrotomic techniques; methods of study in developmental biology; history and discoveries; patterns of reproduction, differentiation and morphogenesis; fertilization, neurulation in invertebrates; development of mosaic eggs; early development in mammals; nucleo-cytoplasm relationship neurotransmitters, differentiation and growth; histogenesis; structural and functional development of endocrine glands; development of immune system.

Practical: Study of normal development with reference to normal tables of developmental stages of fish/frog toad; histology of developing embryo using serial sectioning techniques; study of organogenesis-histogenesis of some organs in fish, frog/toad; morpho-histology of gonads of some seasonal breeders; observations on live gametes; study of regeneration in planaria/hydra/earthworm; tail and limb regeneration in frog, tadpoles; tail regeneration in lizards;

observation on normal metamorphosis in frog, tadpoles; effect of thiourea, thyroxin and prolactins, taxidermy.

Zoo.506 APIDOLOGY 2+1 Sem.II

Classification of Apoidea, their distribution and biology; natural history and life cycle; ecology, social organization, thermoregulation, colony life, behaviour, nutrition and reproduction, physiological adaptations, foraging dynamics of the bloom visitors and energetics of pollination, managed pollination.
Practical: Identification of different kinds of bees, castes, management and doemstication of solitary and social bees, nesting behaviour of different bees, comparative differences in thermoregulation in social bees, artificial feeding, measurement of total population and other parameters of the colony; chromatographic studies of different honeys and nectors, foraging behaviour of bees.

Zoo.507 FUNDAMENTAL OF VERMICULTURE 2+1 Sem. II

Introduction, earthworms, taxonomy and nomenclature, distribution and ecology, food habits of earthworms, vermiculture-the use of earthworms; earthworm and their influence on soil structure and infiltration; earthworms in agroecosystems and land rerclamation; earthworms and sustainable land use. Methods of vermicomposting, chemical composition of worm cast, changes during vermicomposting, economics of vermiculture.
Practical: Earthworms-their type study; their identification and classification, methods of sampling and collection and population estimation, biology study of different life stages, culturing of earthworms, food preferences of earthworms, methods of vermicomposting, chemical changes in organic matter due to earthworms activity.

Zoo.508 AVIAN BIOLOGY AND APPLIED ORNITHOLOGY 2+1 Sem. II

Classification and geographical distribution of birds, morphological adaptations in relation to life in air, feeding habits and aquatic mode of life; nest and nest building; breeding and parental care; habitat and niche; territorial behaviour; voice and sound production; economically useful and harmful birds; bird hazards to aviation and industry;effect of urbanization on birds; measures of conservation of species-global and Indian scenario, organization involved in protection, conservation and Government laws; study of bird sanctuaries of India.
Practical: Classification, identification of locally available avain species; field study of birds; types of nests; methods of capturing and ringing of birds; visit to bird sanctuaries and poultry farms.

Zoo.509 MAMMOLOGY 2+1 Sem.II

Environmental interactions among mammals; activity and behaviour; adaptations; metabolism of population, ecology; communication, migration, effect of some hormones on reproductive functioning; current topics in mammology.
Practical: Identification of different types of mammals specially rodents; factors governing population density; study of rat burrows and their architecture; feeding and exploratory behaviour.

Zoo.510 PRINCIPLES OF ARACHNOLOGY 2+1 Sem.II

General features, classification of arachnids; comparative morphology and anatomy; categories of arachnids with reference to habitat and feeding habits-phytophagus, stored products, house dust and soil mites; molecular, cellular and physiological basis of host-parasite interactions-mites and ticks; role of predatory

mites and spiders in integrated pest management programmes; ecology and ethology; control methods.
Practical: Collection, extraction, preservation, mounting and study of various arachnids, dissection of spiders and mounting of organs and systems, use of rearing technique.

Zoo.601 ADVANCES IN ANIMAL BEHAVIOUR 3+0 Sem.II

Neuron as an information processing unit, basic mechanisms of stimulus transduction, afferent pathways, animal signals, classical ethological approach, ritualization; types of communication signals, their properties and the behavioural functions including mimicry; optimal tactics of foraging predation and reproduction; habitat selection, territorial economics of insect sociality, altruism, cycle behaviour, translocation biological clock, entrainment and resetting; role of exogenous and endogenous factors on rhythmicity.

Zoo.602 FUNCTIONS OF ECOSYSTEM 3+0 Sem. II

Systems ecology; primary and secondary production, rates of production and respiration in animal communities and population; animal response to different environments, stress ecology; pollution, habitat exploitation ecology; recent advances in functions of ecosystem.

Zoo.603 ADVANCED ACAROLOGY 2+1 Sem. I

Specialized morphological adaptations of ticks and mites; macro and micro environmental factors affecting the distribution of mites in different media; mites and postharvest technology, interrelationship between mites and microorganisms, predator-prey interactions with special to biological control of pest species; mites as plant pests and vectors, role of soil mites in edaphic ecosystem; acarines and human health; mites associated with invertebrates and vertebrates; ticks in relation to livestock; recent trends in acarology.

Practical: Collection, preservation and identification of mites upto family; study of life history of some mites.

Zoo.604 ADVANCES IN ORNITHOLOGY 3+0 Sem. I

Population dynamics of birds, patterns of terrestrial bird communities, feeding preferences, nesting and reproductive behaviour, nest competitor, predators and enemies, evolution of gregarious nests, desert birds, aquatic avian ecology -fresh and marine environment, bird damage to field crops and their control measures.

Zoo.605 RODENTOLOGY 3+0 Sem. I

Classification and biology of rodents, geographical distribution and their adaptive patterns; external features; activity pattern for defence and changing environmental, food habits, breeding cycles; family life and communication; population equilibria; rodents as vectors; rodent control, pre and post harvest techniques.

Zoo.606 ADVANCES IN APIDOLOGY 3+0 Sem. I

Evolution of sociality; physiology of caste determination, role of hormones; controversies about bee dances; molecular basis of odour-receptor complex; colony defence; honeybee genetics and breeding, sex determination, semen preservation and insemination; bee products and their chemical nature; bee pathogens, their interactions; bee poisoning, mode of action, effect of pesticides on

and identification of plankton, benthos and periphyton their quantitative and qualitative analysis; identification of common weeds, predatory fishes and harmful insects; estimation of primary productivity; estimation of fish population; analysis of waters for physico-chemical and pollution indicating parameters.

FISH 503 AQUACULTURE-CULTURE AND CAPTURE FISHERIES 2+1 Sem.II

Brief review of piscicultural practices in South-East Asia, criteria of cultivability of a fish, mono-species and multi-species culture techniques and significance, culture of trout, cold water mahseer and common carp, culture of air breathing fishes, sewage fed culture, integrated fish and prawn culture in India, culture of prawns, clams, mussels, oysters and sea weeds, fish culture in fresh and brackish waters, pearl fisheries, inland capture fisheries (including prawn fisheries) of India, ecology and fishery of Chilka lake (Orissa), Pulicat lake (Andhra Pradesh) and back waters of Kerala; Hilsa fishery, causes of its decline, introduction to sport fisheries of India, advances in fishing methods.

Practical: Graphic and numerical methods of estimation of production, fertilization of ponds and study of production of fish food organisms; evaluation of growth of fish in fertilized ponds; collection and study of different aquatic weeds; their control; weed as fish food and compost preparation; identification of various components of a mechanized fishing craft; study of principal types of fishing gears; fishing operations; visit to a fish farm/farms; and sea coast (tour/visit report).

FISH 504 FISH PHYSIOLOGY AND BEHAVIOUR 2+1 Sem. I

Coloration, cardiac activity and its regulation, blood and blood forming organs, transport of respiratory gases by blood, retina of the swimbladder, gills, respiration and osmoregulation, air breathing functions of the kidney, functions of the nervous system-Anatomy and function of the Mauthner neurons; sensory physiology, sound production and detection, electric organs; Luminiscent organs, organs and tissues, neurosecretion, adaptations to special conditions of life, symbiosis and parasitism. Circadian rhythms, annual reproductive cycle, homing, migration and orientation, territoriality, schooling and shoaling.

Practical: Study of changes in chromatophores in fish, effect of epinephrine, NaCl and KCl on fish chromatophores, demonstration of amylase, protease and lipase activities, determination of haemoglobin content in fish blood; determination of the rate of ammonia and urea excretion and oxygen consumption in fish in relation to temperature and salinity; estimation of protein, fat, free amino acid, ash and water contents in fish muscle; study of factors influencing fish behaviour; eye-stalk ablation in carp/prawn and the effect of eye-stalk extract.

FISH.505 FISH REPRODUCTION 2+1 Sem. II

Modes of reproduction; reproductive cycle; hormonal and environmental regulation of reproduction; reproductive behaviour, development, fecundity, natural breeding; wet and dry bundh techniques; induced breeding of fishes with special reference to Indian major carps, brood fish care, post-larval and fry rearing; transport of seed and brood fish; techniques of chromosome manipulation in fish and shellfish-gynogenesis, androgenesis, triploidy, tetraploidy, hybridization etc; production of transgenic monosex fish and super males by combination of endocrine sex reversal and selective breeding; use of drugs/chemicals for producing sterile fish.

Practical: Identification of maturity stages of fish; determination of gonosomatic index; estimation of fecundity; measurement of ova diameter; study of endocrine glands; secondary sexual characters in fish, laboratory trials on manipulating the reproductive cycles in fish and its utility; induced breeding of fish using different ovulating agents; visit to a fish seed production farm and study of components of a fish hatchery.

Fish. 506 AQUARIUM MANAGEMENT, CULTURE AND CONSERVATION OF GAME FISHES 2+1 Sem. I

Present status of ornamental fish trade, different species of ornamental freshwater fishes; their breeding habits and natural history; rearing of larvae and adults; feeds and feeding. Types of aquaria and maintenance, common aquarium plants and their multiplication; ornamental objects, aerators, and filters used in aquaria, setting up of marine aquaria, packaging and transport of tropical ornamental fishes, commercially important game fishes of the world, life history of trouts, mahseer and snow trouts, their ecological requirements, hatchery production and transportation of fish seed; feeding of larvae; rearing to adult size. Management of sport fisheries, methods of conservation of game fishes, provision of a sanctuary, fishing regulations, ranching etc.

Practical: Study of different species of ornamental fishes, breeding and rearing, maintenance of aquaria, study of common aquarium plants; multiplication of plants. Preparation of artificial sea water, study of marine ornamental fishes and other animals, identification of important game fishes available in India.

FISH.507 FISH PRODUCTS TECHNOLOGY 2+1 Sem. I

Introduction, properties of fish meat-chemical, physical, and thermal, allometric relationships-fin fish, shell fish, quantitative textural test, properties of fish oils, different fish processing techniques -heat processing and canning, problems with canned fish products, refrigeration processes, salting, drying, smoking, fermented products, irradiation, MAP, hypobaric storage, gas exchange, packaging, packaging regulations, Byproducts-fish meal, fish oil, hydrolyzed fish products, fish protein concentrate, minced fish, fish roe, pharmaceutical products, leather, glue, Isinglass, pearl essence, other fin fish by-products, shellfish by-products. Quality changes in fish food products, factors influencing quality, spoilage of marine and fresh water fish food products, methods of quality assessment.

Practical: Preparation of different cured fishery products-dried, salted, smoked, pickled, preparation of fish hydrolysates, quality assessment of various fishery products.

FISH. 591 SEMINAR 1+0 Sem I/ II
FISH. 600 MASTER'S RESEARCH

SUPPORTING/MINOR

FST.512 FISH PRODUCTS TECHNOLOGY

Introduction, properties of fish meat-chemical (thermal conductivity, specific heat, heat respiration, enthalpy, thermal diffusivity), Physical: Allometric relationships-shellfish, fin fish, quantitative textural test, coefficient of function. Properties of fish oils. Fish harvesting systems, handling at harvest, processing systems (Fin fish, crustaceans, Molluscs). Processing of fish-unloading, stunning, washing, sorting, grading, singulation, orientation, scaling, heading, shuckling, picking, peeling, evisceration, filtering skinning, candling, cutting, block formation applying, butter, breading, frying, retorting, meat bone separation. Heat processing and canning, problems with canned fish product. Refrigerated processes, purpose of refrigeration, loads, system components, refrigeration systems, salting, drying, smoking fermented products, irradiation, MAP, Hyobaric storage, gas exchange. Packaging, function of packages, package selection, packaging materials, packaging regulations. By-products-fish meal, fish oil, hydrolyzed fish products, fish protein concentrate, minced fish, fish roe, pharmaceutical products, leather, glue, Isinglass, pearl essence, other fin fish by-products, shellfish by-products.

Quality changes in fish food products, factors influencing quality, spoilage of marine and fresh water fish food products, quality loss and its control. Methods of quality assessment, sensory, physical, chemical, microbiological, statistical.

Practical: Preparation of different cured fishery products-dried salted, smoked, pickled. Preparation of fish hydrolysates. Quality assessment of various fishery products.

FIELD OF SPECIALIZATION. Fish nutrition, Fish reproduction, Limnology and Aquatic Pollution
FOR Ph.D. FISHERIES

FISH-508 AQUATIC ANIMAL HEALTH & MANAGEMENT 2+1 Sem.I

General classification of fresh water fish diseases, infectious, viz., fungal, bacterial, viral, protozoanal and crustacean diseases and their control measures. Non-infectious diseases viz., Asphyxiation (gas disease and other types of asphyxiation), dysentery and nutritional deficiency diseases and their control measures, histological and immunological impacts due to diseases, physiological damage due to disease stress; quarantine methods and problems.

Practicals: Pond preparation and maintenance of water quality for good hygienic conditions; studies of hydrobiological factors influencing fish diseases; sampling and diagnostic procedures; identification of fungal, bacterial, protozoanal, crustacean and worm diseases; identification of some common aquarium fresh water fish diseases.

FISH-509 ECONOMICS OF FISHERIES & MARKETING 2+1 Sem.I
(To be offered in collaboration with Ag. Econ.)

Principles of economics, basic terms and concepts, laws of demand and supply, and laws and returns. Non-monitory factors. Principles of market evaluation and market development, consumer surplus. International trade, export promotion and foreign exchange regulations. Financial appraisal techniques. Defining costs and returns in aquaculture projects. Existing systems of fish marketing. Role of co-operatives in marketing of aqua products.

Practical: Project reports on present fish market status and development; prospects of International trade; foreign exchange programme and regulations; role of fisheries cooperative societies in the state; marketing of processed fish products.

FISH-601 FISH POND ECOYSTEM 2+1 Sem.II

Pond soil and its characteristics: pH, nitrogen, phosphorus, calcium, sulphur, iron, organic matter and humus, physico-chemical characteristics of pond water, importance of alkalinity, hardness, pH and carbon dioxide, liming and its importance, nutrients in water, rules for the use of fertilizers, nitrogen and nitrogen compounds, nitrogen and phosphorus cycling in water, inorganic fertilizers and their application, organic fertilizers, their role and use, other nutrients involved in pond productivity, fish production and production factors: primary and secondary productivity, phytoplankton biomass and primary productivity, importance of elimination of algae, microphytes, plankton behaviour and life strategies, influence of zooplankton on plankton community, bacterial food loop, its contribution to production, pond stocking, management practices and production factors, critical factors limiting production, fish populations and fish yield dynamics.

Practical: Project reports on physico-chemical characteristics of pond water, pond productivity, zooplankton communities and pond stocking.

FISH-602 LIMNOLOGY AND AQUATIC POLLUTION 2+1 Sem.II

Lake morphometry: Concept of formation of lakes and reservoirs, the impact of catchments on productivity of the lake system, thermal stratification, buoyancy, temperature, turbidity, light penetration, heat budget, evaporation, water movements (waves, currents and seiches), limnochemistry.

Different kinds of aquatic pollution sources like domestic sewage, industrial effluents, radioactive substances, heavy metals and agricultural wastes, biological indicators, use of fish in bioassays, concepts of LC_{50} , pesticide residues and its biomagnification and waste recycling in fisheries, Limnology in relation to mankind.

Practical: Project reports on lake morphometry, industrial effluents in fresh waters, biological indicators and biomagnification.

FISH 603 ADVANCES IN FISH REPRODUCTION 3+0 Sem. I
(Pre-requisite Fish-505)

Cell and molecular biology of gametogenesis, yolk formation and differentiation; hormonal control of oocyte maturation and ovulation, spawning and spermiation; functional morphology of teleost gonads; role of brain and neurohormones, gonadal steroids and gonadotropins in fish reproduction; role of extrinsic and intrinsic factors in sex control and sex reversal; role of hormones and pheromones in reproductive behaviour; neuropeptides and hormones in fish breeding; role of steroids in aquaculture; hormonal sex control and its application in fish culture; role of environmental factors; pineal and eyes in gonadal activity.

FISH-604 ADVANCES IN FISH NUTRITION 3+0 Sem. I
(To be offered in collaboration with Animal Nutrition)
(Pre-requisite ANN-509)

Calories and energy requirements, energy pathways; maintenance; requirements of protein, amino acids and other essential nutrients for growth, natural food and its estimation, fish growth and fish yield relationships. Supplementary feed and its utilization Energetics of feeding and digestion. Feed formulation, evaluation and nutritional studies. Laboratory and field studies of energy budgets. Energetics and fish farming, nutrition; hormonal control of metabolism and feeding of hatchlings.

FISH-591 SEMINAR 2+0 Sem. I/ II
FISH-700 Ph.D. Research