SECTION X

FACULTY OF BASIC SCIENCES AND HUMANITIES

General Information

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COLLEGE OF BASIC SCIENCES AND HUMANITIES

Basic Sciences provide scientific capital from which practical application of knowledge is drawn. Keeping in view the significance of basic sciences and humanities for proper understanding and development of different areas of agriculture and allied fields, the College of Basic Sciences and Humanities was established in October, 1965. Dr A S Kahlon was the founder Dean of the College and he continued in this position up to October, 1978. Subsequently, Dr Kulbir Singh Gill (December, 1978 to February, 1982; August, 1983 to January, 1986), Dr I S Bhatia (February, 1982 to July, 1983), Dr S S Guraya (January, 1986 to May, 1990), Dr C P Malik (June, 1990 to June, 1994), Dr D R Singh (June, 1994 to July, 1996), Dr H S Garcha (April, 1998 to March, 2000), Dr M.A. Zahir (April, 2000 to December, 2002), Dr A P S Mann (January, 2003 to September, 2005) and Dr Tejwant Singh (October, 2005 to July, 2009), Dr R S Sidhu (December, 2009 to January, 2015) served as Deans of the College. Presently, Dr (Ms) G K Sangha is working as the Dean of the College since March, 2015. As a constituent college of the University, the College of Basic Sciences and Humanities strives to be a centre of excellence for advanced studies in the various fields within its jurisdiction.

Its teaching and research objectives are:

i) To impart training and to equip students in basic sciences and humanities (both at UG and PG levels) to provide a scientific base for proper understanding and appreciation of the applied subjects of agriculture, home science and agricultural engineering and technology as well.

ii) To perform integrated functions of resident instruction, research and extension in all the disciplines of basic sciences and humanities.

iii) To promote inter-disciplinary resident instruction, research and extension education programmes at the Punjab Agricultural University.

Before the establishment of PAU, the subjects in basic sciences were taught to B.Sc. (Agri) students by different sections of Govt. Agricultural College, Ludhiana. After the establishment of PAU in 1962, five independent departments (viz., Department of Agricultural Journalism, Languages and Culture; Department of Chemistry and Biochemistry; Department of Economics and Sociology; Department of Genetics and Department of Physics, Mathematics and Statistics) were created in 1963 to teach the subjects of basic sciences and humanities.

The Department of Microbiology was established in the College in 1969. The Department of Business Management was established in 1971 to train students in entrepreneurship and management disciplines. Two more independent departments were established in 1972, viz., Department of Botany by splitting the Department of Botany and Plant Pathology (COA) and Zoology by splitting the Department of Zoology and Entomology (COA). In the same year, an independent Department of Physics was also carved out of combined Department of Physics, Mathematics and Statistics. In 1976, the Department of Chemistry was established by bifurcating the Department of Chemistry and Biochemistry. Keeping in view the role of biotechnology in augmenting agricultural production, an independent Biotechnology Centre was established in 1992 which was merged with Department of Genetics in the year 2000, which has now been shifted to the College of Agriculture. An independent Department of Fisheries was carved out from the Department of Zoology in 1994, which was later shifted to Guru Angad Dev Veterinary and Animal Sciences University in the year 2006. The upgradation of the Department of Business Management to School of Business Studies was done in the year 2012.

At present, the College has eight departments namely, Agricultural Journalism Languages and Culture; Biochemistry; Botany; Chemistry; Economics and Sociology; Mathematics, Statistics

and Physics; Microbiology; Zoology and one School i.e. the School of Business Studies. The College is running 28 teaching programmes, which comprise 8 Ph.D., 12 M.Sc., 5 M.Sc.(Hons) Integrated and 1 Diploma in French, in addition to two Certificate Courses, one in French, and the second in Interactive Skills and Personality Enhancement.

The details of various degree courses are given below. The year of start of these programmes is shown in parentheses.

Agricultural Economics	M.Sc. (1963), Ph.D. (1965)
Biochemistry	M.Sc. (1963), Ph.D. (1963), 5-year Integrated M.Sc. Hons (2008)
Botany	M.Sc. (1963), Ph.D. (1968), 5-year Integrated M.Sc. Hons (2008)
Business Administration	MBA (1971), Ph.D. (1971)
Business Administration (Agribusiness)	MBA (2004)
Chemistry	M.Sc. (1968), Ph.D. (1972), 5-year Integrated M.Sc. Hons (2011)
Journalisim and Mass Communication	MJMC (2008)
Microbiology	M.Sc. (1969), Ph.D. (1972), 5-year Integrated M.Sc. Hons (2008)
Physics	M.Sc. (2011)
Statistics	M.Sc. (2016)
Sociology	M.Sc. (1967), Ph.D. (1969)
Zoology	M.Sc. (1972), Ph.D. (1972), 5-year Integrated M.Sc. Hons (2008)

M.Sc. and Ph.D. programmes in Statistics were started in 1966 and 1968 but discontinued from academic year 1999-2000 and 1998-99, respectively. M.Sc. in Statistics has been revived w.e.f. academic year 2016-17. Ph.D. programme in Physics was started in 1992 but discontinued from the academic session 1998-99. B.Sc. (Hons) programmes in Biochemistry, Botany, Chemistry, Statistics and Zoology were initiated from academic session 1970-71. The programme in Statistics was discontinued from the academic session 1975-76 while the remaining 4 programmes were discontinued from the academic session 1985-86. Total number of students who received B.Sc.(Hons) degree were 366 (Biochemistry-106, Botany-70, Chemistry- 96, Statistics-10 and Zoology-84).

The College of Basic Sciences and Humanities has a special role to play in the University because it gives support to all the other Colleges. The College, through its own Board of Studies, approves courses in basic sciences and humanities for all the constituent colleges of the University, as per their needs and requirements. Since students in the College of Agriculture, College of Home Science and College of Agricultural Engineering and Technology are admitted after 10^{th} and 10+2, they are deficient in knowledge in some of the basic sciences and the languages. For the students admitted after 10^{th} at IOA, Gurdaspur and IOA, Bathinda, the new courses were framed to make them equivalent with PSEB curriculum of 10+1 and 10+2. The courses offered by the College, thus, form the scientific base for studying applied courses for the students of these colleges. Many of the courses offered by the various departments of the College are taken by the postgraduate students of different disciplines of the other colleges as minor or supporting courses.

The undergraduate and postgraduate courses offered by the College were revised and

updated in the academic year 1982-83. Later on, when the University switched over to semester system in 1988-89, all the courses were again revised/rescheduled and new courses were designed to impart knowledge in Molecular Biology, Genetic Engineering and Biotechnology, Physiology of Plants and Animal and specialized areas in Microbiology including mushroom cultivation. Based on recent advances and changing scenario in sciences, again many of the courses have been revised/modified and new courses added in the academic year 1998-99. New curricula was designed for M.Sc. (Hons) 5 year Integrated programmes in 2008. The entire curriculum for PG courses was restructured again in the year 2010-11 in accordance with the ICAR guidelines. The undergraduate courses offered by the College has been revised as per Fifth Deans' Committee recommendations.

The College has well equipped centralized facilities such as PG Research Laboratory, Molecular Biology Laboratory and Computer Laboratory to cater to the needs of faculty and research scholars. The College has been recognized for its role through various awards and honours received by the faculty and students over the years. The distinguished awards include Shanti Swaroop Bhatnagar Award, Rafi Ahmed Kidwai Award, Hari Om Trust Ashram Award, Hira Lal Chakraborty Award, Basanti Devi and Amar Chand Award and the RT Doshi Foundation Award. The faculty/students have been nominated/elected fellows of NAAS, FNA, German Academic Exchange (DAAD) Fellowship, Fulbright Nehru Fellowship, Cambridge Nehru Scholarship, Commonwealth Academic Staff Scholarships and others.

BIOCHEMISTRY

PROGRAMMES

M.Sc.

Ph.D.

Five Year Integrated M.Sc. (Hons)

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Plant Biochemistry, Molecular Biochemistry, Enzymology, Abiotic and Biotic Stress Biochemistry.
Required Courses	Biochem. 501, Biochem. 502, Biochem. 503, Biochem. 504, Biochem. 505, Biochem. 506.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than minor) relating to area of special interest and research problem
Minor Fields	Botany, Microbiology, Food Science and Technology, Plant Breeding and Genetics, Biotechnology or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies.

Ph.D.

Field of Specialization	Plant Biochemistry, Molecular Biochemistry, Enzymology, Abiotic and Biotic Stress Biochemistry.
Required Courses	Biochem. 601, Biochem. 602.
Supporting Courses	Courses from subject matter fields (other than minor) relating to area of special interest and research problem.
Minor Fields	Botany, Microbiology, Food Science and Technology, Plant Breeding and Genetics, Biotechnology or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies.

Five Year Integrated M.Sc. (Hons)

Field of Specialization	Plant Biochemistry, Molecular Biochemistry, Enzymology, Abiotic and Biotic Stress Biochemistry.
Required Courses	All courses listed for semesters I to VI (Page No.___*) and Biochem. 501, Biochem. 502, Biochem. 503, Biochem. 504, Biochem. 505 and Biochem. 506.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter field (other than Minor) relating to the area of special interest and research problem.
Minor Fields	Botany, Microbiology, Food Science and Technology, Plant Breeding and Genetics, Biotechnology or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies.

* Page number according to new RBI.

DESCRIPTION OF COURSE CONTENTS

Undergraduate courses/Integrated M.Sc. (Hons)

Biochem. 101 Introduction to Biochemistry 2+1 Sem. I

Importance of Biochemistry. Properties of Water, pH and Buffer. Carbohydrate: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Polysaccharides. Lipid: Importance and classification; Structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: Importance of proteins and classification; Structures, titration and zwitter ions nature of amino acids; Structural organization of proteins. Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes. Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

Practical: Preparation of solution, pH & buffers, Qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids/ Free fatty acids, Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides.

Biochem. 102 Nutritional Biochemistry-I 2+1 Sem. I

Introduction to Biochemistry - Definition, objectives, scope and inter relationship between biochemistry and other biological sciences. Enzymes - Definition, types and classification of enzymes, definition and types of coenzymes, specificity of enzymes, isozymes, enzyme kinetics including factors affecting enzyme action, velocity of enzyme catalyzed reactions, enzyme inhibition. Intermediary metabolism. Carbohydrate metabolism- glycolysis, TCA cycle and energy generation, gluconeogenesis, glycogenesis, glycogenolysis, blood sugar regulation. Lipid metabolism - oxidation and biosynthesis of fatty acids (saturated and mono-unsaturated), synthesis and utilization of ketone bodies, ketosis, fatty liver. Protein metabolism - general reactions of amino acid metabolism, urea cycle, lipoproteins - types, composition, role and significance in disease.

Practical: Handling of equipment and instruments, preparation of samples, solutions and buffers, blood constituents: Estimation of serum protein (Biuret method and Lowry method), blood glucose (Folin Wu method), serum inorganic phosphorus (Fiske and SubbaRow method), creatinine, Urine constituents: Estimation of protein levels, glucose levels in urine, ketone bodies in urine, urine constituents- Repeat.

Biochem. 103 Nutritional Biochemistry- II 3+0 Sem. II

Role of major biomolecules in nutrition. Introduction to nucleic acids-DNA, RNA and their structure, replication, transcription, genetic code and biosynthesis of proteins. Vitamins - chemistry and biochemical role of fat-soluble vitamins - A, D, E and K, water soluble vitamins - B1, B2, B6, niacin and vitamin C. Biochemical role of minerals in nutrition- macrominerals- calcium, iron, magnesium, sodium, potassium, chloride, phosphorus and sulphur, microminerals – iodine, zinc, copper, chromium, selenium, cobalt, fluoride and manganese. Anti-nutrients and antioxidants in human health. Digestion and absorption of carbohydrates, lipids, proteins, vitamins and iron. Bile acid metabolism. Molecular aspects of transport, passive diffusion, facilitated diffusion, active transport of sugars and amino acids. Basal metabolism and caloric requirements. Balanced diet. Metabolic disorders of macromolecules- glycogen storage diseases, lipidosis, dyslipidemias and atherosclerosis. Evaluation of protein quality by chemical and biological methods. Protein energy malnutrition- marasmus and kwashiorkor and their management.

Biochem. 104 Principles of Biochemistry 2+1 Sem. II

Recapitulation of basic chemistry and biology. Water, pH and buffers. Acid-base balance. Cellular constituents and their structure and function, amino acid and proteins, carbohydrates, lipids and bio-membranes, nucleic acids. Dissolved molecules – vitamins and minerals. Enzymes-function, properties and mechanism. Metabolism of cellular constituents, basic concepts of bioenergetics. Carbohydrate metabolism-glycolysis and glycogenolysis, HMP pathway, TCA cycle and gluconeogenesis. Electron transport chain. Photosynthesis. Lipid metabolism-β-oxidation, ketone bodies, fatty acid synthesis. Amino acid metabolism - general reactions of nitrogen assimilation and excretion. Biosynthesis of DNA, RNA and protein-replication, transcription, translation and genetic code. Regulation of gene expression.

Practical: Preparation of buffers and pH determination. Preparation of colloids. Qualitative and quantitative tests of carbohydrates, lipids and proteins. Tests of enzyme action- potato oxidase, urease, salivary amylase. Paper chromatography of amino acids or carbohydrates ascending and descending. Determination of starch and sugar. Analysis of proximate constituents in food.

Biochem. 203 Structure and Function of Biomolecules 3+0 Sem. II

Development and scope of Biochemistry. Biochemical composition of living organisms. Water as a solvent of life. Buffers and Henderson-Hasselbalch equation. Structure and functions of simple and complex carbohydrates. Lipids: classification, structure and functions; Proteins: structures of amino acids, concept of peptide bond, levels of protein structure and protein functions. Nucleic acid: nucleoside, nucleotides, structure of DNA and RNA and their functions. Vitamins and coenzymes.

Biochem. 204 Metabolism I 2+0 Sem. I

Bioenergetics: concept of free energy, high energy compounds, redox reactions, chemical potential, electrochemical potential, electron transport system and oxidative phosphorylation. General features of regulation of metabolism. Metabolism of carbohydrates: glycolysis, gluconeogenesis, tricarboxylic acid cycle. Pentose phosphate pathway and its significance. Metabolism of glycogen. Diseases of disorders of carbohydrate metabolism. Concept of G-proteins.

Biochem. 205 Metabolism II 3+0 Sem. I

Approaches to study metabolism, oxidation of fatty acids. Biosynthesis of fatty acids. Biosynthesis of phospholipids. Phospholipases. Metabolism of amino acids. Nitrogen cycle. Urea synthesis. Biosynthesis and degradation of purine and pyrimidine nucleotides. Biosynthesis of deoxy-ribonucleotides. Diseases of disorders of lipids, amino acids and nucleic acids metabolism. Integration of metabolism and its regulation.

Biochem. 206 General Enzymology 2+0 Sem. II

Classification and nomenclature of enzymes. General characteristics of enzymes. Active site, cofactors, prosthetic groups; metallo-enzymes. Enzyme assays and international units. Enzyme kinetics: significance of Km and V_{max} and their determination using Lineweaver-Burk plots. Enzyme inhibition: Reversible and irreversible, competitive, non-competitive and uncompetitive with graphical representations. Brief mention of allosteric enzymes and isoenzymes. Biotechnological and clinical applications of enzymes.

Biochem. 207 Basic Biochemistry 3+1 Sem. II

Introduction and importance. Cell structure. Bio molecules - structure, functions and properties of carbohydrates, lipids, proteins and nucleic acids. Enzymes – classification and factors affecting activity. Structure and role of water in biological system. Acids, bases and buffers of living systems. The pK of biomolecules. Vitamins- chemistry, classification, biochemical role and deficiency diseases. Hormones - classification, general mode of action and role in metabolism.

Bioenergetics. Metabolism - basic concept, Glycolysis, Citric acid cycle, Pentose phosphate pathway, Oxidative phosphorylation, Fatty acid oxidation. General reactions of amino acid degradation-transamination, deamination, decarboxylation and urea cycle. Biosynthesis - carbohydrates, lipids, proteins and nucleic acids. Secondary metabolites - terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.
Practical: Qualitative tests for carbohydrates, amino acids, proteins and lipids. Extraction and characterization of lipids by thin layer chromatography. Determination of acid, iodine and saponification values of oil. Extraction, quantitative estimation and separation of sugars by paper chromatography. Determination of phenols. Determination of free amino acids and proteins.

Biochem. 208 Food Biochemistry and Nutrition 2+1 Sem. II
Biochemistry and its scope. Occurrence, classification, structures, physicochemical and metabolic functions of carbohydrates, proteins and lipids. Nucleic acids - properties, structure and metabolism. Enzymes - chemical nature, nomenclature, classification, sources and properties, mechanism of action, coenzyme and prosthetic groups, regulation of enzymatic activity, enzyme kinetics, inhibition, effects of pH, allosteric enzymes, derivation of Michaelis-Menten equation. Concepts and content of nutrition - water and energy balance, water intake and losses, basal metabolism. Formulation of diets - classification and preparation of balanced diet, recommended dietary allowances for various age groups. Malnutrition - assessment of nutritional status, food fad and faddism. Potentially toxic substance in human food. Basic food groups and nutrients supplied by food. Digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings. Metabolism of carbohydrates - glycolysis and respiration, production of ATP, brief description of electron transport chain, oxidative and substrate phosphorylation. Metabolism of Lipids- β-oxidation of fatty acids, ketosis, fatty acid synthesis. Metabolism of proteins- breakdown of proteins, transamination, deamination, decarboxylation and urea cycle. Minerals - functions, sources and effects of deficiency. Factors affecting absorption of minerals, promoters and inhibitors. Vitamins and hormones - classification, functions, sources and effects of deficiency. Fat soluble and water-soluble vitamins. Physico-chemical and nutritional changes during food processing - drying and dehydration, irradiation, freezing, fermentation, canning, restoration, enrichment, fortification and supplementation of foods.
Practical: Preparation of various solutions and buffers. Qualitative and quantitative determination of carbohydrates, amino acids, proteins and lipids. Isolation of enzymes from various sources. Determination of pKa of acid and pI for casein. Separation of amino acids using paper chromatography, thin layer chromatography and electrophoresis. Estimation of phosphorus, calcium and iron in food samples. Estimation of β-carotene using column chromatography. Vitamins -Estimation of ascorbic acid using dye method. Effects of acids and alkali on pigments.

Biochem. 301 Introduction to Molecular Biochemistry 3+0 Sem. I
Introduction; Structure of DNA (A, B and Z) and RNA, DNA replication: semi-conservative mode of replication and its experimental verification. Enzymes involved in DNA replication. Differences between prokaryotic and eukaryotic replication. RNA biosynthesis: Initiation, elongation and termination, reverse transcriptase. Genetic code: Elucidation and general features. Protein synthesis, enzymes involved in translation. Post-transcriptional processes. Introduction to operon concept (lac-operon) and regulation of gene expression.

Biochem. 302 Basic Experiments in Biochemistry 0+3 Sem. II
Qualitative tests for carbohydrates, lipids, proteins and amino acids. Determination of acid, iodine and saponification values of fats and oils. Extraction of total lipids and total sugars. Estimation of total sugars, reducing sugars and starch. Starch hydrolysis by amylase. Preparation of buffers. Determination of acid phosphatase from mungbean. Separation of sugars by paper chromatography and lipids by thin layer chromatography.

Biochem. 303 Introduction to Membrane Biochemistry 3+0 Sem. I

Chemical composition of biomembranes. Role of phospholipids and proteins, models of cell membranes. Functions of membranes: energy transduction, signal recognition and transduction. Nutrient transport across membranes. Active and passive transport. Pumps: examples and metabolic significance. Bacteriorhodopsin. Membrane fluidity and receptor functions.

Biochem. 304 Enzymology and Enzyme Technologies 2+1 Sem. I

Classification and nomenclature of enzymes. General characteristics of enzymes. Active site. Cofactors and prosthetic groups. Metalloenzymes. Isolation, purification, characterization and assays of enzyme and international units. Criteria for purity. Enzyme kinetics- effect of pH, temperature, enzyme and substrate concentration. Determination of Km and Vmax. Regulation of enzyme activity. Enzyme inhibition- competitive, non-competitive and uncompetitive. Isoenzymes, schizomers and isoschizomers. Ribozymes, Immobilization of enzymes. Applications of enzymes in biotechnology, industry, environment, agriculture, food and medicine. Practical: Isolation, purification and assay of enzymes. Determination of optimum pH and optimum temperature of enzymes. Thermostability of enzymes. Activators and inhibitors of enzyme catalysis. Determination of kinetic parameters of enzymes. Immobilization of enzymes. Isoenzymes analysis

Biochem. 421 Fundamentals of Biochemistry 3+0 Sem. I & II

Cell structure and function. Structure and role of water in biological system. Acids, bases and buffers of living systems. The pK of biomolecules. Classification of enzymes. Effect of substrate, temperature, pH, activators and inhibitors on enzyme catalysis. Vitamins and hormones. Bio-membranes structure and function. Bioenergetics and oxidative phosphorylation. Metabolism of carbohydrates, lipids, proteins, nucleic acids. Photosynthesis and respiration. DNA replication, transcription and translation. Regulation of transcription. Recombinant DNA technology. Secondary plant products.

Biochem. 423 Fundamentals of Molecular Biochemistry 2+0 Sem. I

Introduction. Structure and functions of nucleic acids. Nucleic acids as genetic material. DNA sequencing. DNA replication, mutations and repair mechanism. Transcription and post transcriptional modifications. Genetics code. Protein biosynthesis. Protein targeting. Regulation of gene expression at the level of transcription. Recombinant DNA and concepts of biotechnology.

Biochem. 424 Experiments in Biochemistry 0+3 Sem. I & II

Concepts of pH and buffers. Determination of total sugars, reducing and non-reducing sugars, starch, free fatty acids, cholesterol and phospholipids. Determination of free amino acids and proteins. Separation of sugars by paper chromatography. Extraction of lipids, separation of polar and non-polar lipids by TLC. Fatty acid composition by GLC. Estimation of Vitamin C and tocopherols. Isolation and purification of acid phosphatase. Estimation of chlorophyll, carotenoids and phytic acid. Extraction and estimation of nucleic acids.

Biochem. 425 Fundamentals of Plant Biochemistry 2+0 Sem. I

Structure and function of cell wall and cell organelles. Photosynthesis and photorespiration. Sucrose transport. Biosynthesis of structural and storage carbohydrates, proteins and lipids. Biochemistry of seed development. Biological nitrogen fixation. Nitrogen and sulfur metabolism. Secondary plant products and their role. Growth regulators. Biochemistry of biotic and abiotic stresses. Carbohydrate and lipid metabolism during germination.

Biochem. 426 Fundamentals of Animal Biochemistry 3+0 Sem. II

Composition and secretion of digestive juices. Digestion and absorption of lipids, proteins, carbohydrates and nucleic acids. Role of lipoproteins in transport of lipids. Acid base balance in kidney and lung functions. Composition of blood and blood clotting. Metabolism and functions of hemoglobin. Biochemistry of specialized tissues like muscles, eyes, nerves and connective tissues. Hormones and their mechanism of action. Role of thyroid, pituitary and calcium metabolizing hormones. Detoxification of xenobiotics. Introduction to immune system and immune cells. Antibodies: classes and functions. Antigen-antibody interactions. Production of monoclonal and polyclonal antibodies.

Biochem. 429 Biochemical and Biophysical Techniques 3+0 Sem. II

Separation techniques like salt and organic solvent fractionation; dialysis, osmosis and ultra-filtration. Chromatographic techniques- partition, adsorption, ion exchange, thin layer, molecular sieve, affinity, high pressure liquid chromatography and GLC. Electrophoresis and isoelectric focusing. X-ray diffraction, ORD and circular dichroism and their application. Lyophilization. Centrifugation techniques: basic principles of sedimentation; centrifuges of various types; Rotors: differential centrifugation, density gradient centrifugation, applications of the analytical ultracentrifuge. Instrumentation methods-IR, UV and visible spectrophotometry, spectrofluorimetry, ESR, NMR spectroscopy. Atomic spectroscopy, Radioactive counters. Radioisotopes in biology: Applications and precautions.

Biochem. 430 Fundamentals of Enzymology 3+0 Sem. II

Introduction to enzymes. Naming and classification of enzymes. Enzymes specificity, cofactors, coenzymes and prosthetic groups. Isozymes, nature of active site, concept of pKa of amino acids. Identification of functional groups of active site. Factors responsible for catalytic efficiency of enzymes. Concept of initial velocity, enzyme units, specific activity, Michaelis-Menten equation, concept of Km and V_{max}. Enzyme inhibition and activation, bi-substrate reactions, regulation of enzyme activity. Allosteric enzymes. Enzyme isolation and purification. Enzyme immobilization. Biotechnological applications of enzymes.

Biochem. 431 Fundamentals of Membrane Biochemistry 2+0 Sem. II

Membrane composition and functions. Various models of unit membrane structure. Comparison of membranes of cells and organelles. Distribution of membrane compounds and their role in organization of membrane and cellular recognition. Membrane transport mechanisms. Membrane channels and pumps. Gap junctions and tight junctions. Transport of different nutrients. Membrane mediated processes and membrane receptors. Signal recognition and transduction.

Postgraduate Courses

Biochem. 501 General Biochemistry 3+0 Sem. I

Fundamental principles governing life; structure and biological functions of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Vander Waals forces. Classification, structure and function of carbohydrates, lipids and nucleic acids. Primary, secondary and tertiary structures of proteins. Protein folding and stability. Protein sequencing. Structure and biological functions of vitamins. Enzymes classification and mechanism of action, regulation, factors affecting enzyme action. Hormones and their mode of action. Bioenergetics, oxidative phosphorylation. Photosynthesis and respiration. General metabolism of carbohydrates, proteins and lipids. DNA replication, transcription and translation. Recombinant DNA technology.

Biochem. 502 Intermediary Metabolism 3+0 Sem. II

The living cell a unique chemical system, introduction to metabolism, methods of studying

metabolism, transport mechanism, biological oxidation, signal transduction. Catabolic and anabolic pathways of carbohydrates, lipids, regulation and their metabolic disorders. Energy transduction and oxidative phosphorylation, general reactions of amino acid metabolism, degradative and biosynthetic pathways of amino acids and their metabolic disorders. Nucleic acid biosynthesis, degradation and regulation. Sulphur metabolism, metabolic engineering concepts compartmentation of metabolic pathways, metabolic profiles of major organs and regulation of metabolic pathways. Integration of metabolism.

Biochem. 503 Enzymology 2+0 Sem. I

Enzyme nomenclature and classification. Enzyme compartmentalization in cell organelles. Isolation and purification of enzymes, measurement of enzyme activity. Ribozymes, isozymes, abzymes, enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis. Cofactors, coenzymes their structure and role, enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity. Applications of enzymes in chemical and food industry, enzyme immobilization, biosensors and clinical applications of enzymes.

Biochem. 504 Molecular Biochemistry 3+0 Sem. II

Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA. Genome organization in prokaryotes and eukaryotes, super coiling. DNA replication, DNA repair, recombination, reverse transcriptase, repetitive and non-repetitive DNA, satellite DNA. Transcription in prokaryotes and eukaryotes process, RNA editing, RNA processing. Genetic code, ribosome structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl t-RNA synthases, inhibitors of replication, transcription and translation. Translation and post translational modification; protein targeting, nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes, molecular mechanism of mutation. DNA sequencing, recombinant DNA technology, different types of vectors, genomic and cDNA library, selection of recombinants, PCR, site directed mutagenesis. Application of recombinant DNA technology.

Biochem. 505 Techniques in Biochemistry 2+0 Sem. I

Chromatographic and electrophoretic methods of separation: Principles and applications of paper, thin layer and HPTLC, gas-. liquid chromatography, HPLC and FPLC; paper and gel electrophoresis, different variants of polyacrylamide gel electrophoresis (PAGE) like native and SDS-PAGE, 2D-PAGE, capillary electrophoresis. Spectrophotometry: Principles and applications of UV-Visible, fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X- Ray spectroscopy. Hydrodynamic methods of separation of biomolecules. Viscosity and sedimentation-their principles, variants and applications. Tracer techniques in biology: concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of α, β and γ emitters, scintillation counters, γ rays spectrometers, autoradiography, and application of radioactive tracers in biology, principles and applications of phosphor imager.

Biochem. 506 Practicals in Biochemistry 0+3 Sem. I

Isolation and determination of important metabolites like soluble sugars, starch, glycogen, amino acids, proteins and peptides, urea, uric acid, fatty acids, triacylglycerols, phospho- and glyco-lipids, cholesterol from tissues/serum. Applications of paper, thin layer and gas liquid chromatography. Estimation of enzymes of clinical importance. Study of the effect of enzyme and substrate concentrations and determination of Km and Vmax, hemoglobin, vitamins, RNA and DNA. Restriction fragmentation and separation of DNA fragments by agarose electrophoresis. RAPD analysis of DNA Isolation, purification and characterization of enzymes by gel permeation, ion exchange and affinity chromatography. Estimation of nitrate reductase, Isolation of plant and animal cell organelles. Application of centrifugation, PAGE, FPLC and HPLC in the separation of biomolecules. Use of radioisotopes in metabolic studies. Antibody

antigen reaction. Enzyme immobilization. Application of PCR. Antigen-Antibody interaction, ELISA.

Biochem. 507 Immunochemistry 2+0 Sem. II

History and scope of immunology, antigens, Adjuvants, immune system, organs, tissues and cells, immunoglobulin's, molecular organization of immunoglobulin. Classes of antibodies, antibody diversity, theories of generation of antibody diversity, vaccine, monoclonal antibodies, polyclonal antibodies, hybridoma, recombinant antibodies, complement system-classical and alternate. Cellular interactions in the immune response, major histocompatibility complex, cell mediated immune response, cytokines. Immunoregulation, immunological tolerance, hypersensitivity, mechanisms of immunity, Innate resistance and specific immunity. Current immunological techniques-ELISA, RIA.

Biochem. 508 Plant Biochemistry 3+0 Sem. I

Plant cell organelles and their separation, structure and function of cell organelle. Photosynthetic pigments in relation to their functions, photosynthesis, C_3, C_4 and CAM pathways, photorespiration. Synthesis and transport of sucrose, phloem loading and unloading, sucrose-starch interconversion, biosynthesis of structural carbohydrates, storage proteins and lipids. Biochemistry of nitrogen fixation and nitrate assimilation, sulphate reduction and incorporation of sulphur into amino acids. Biochemistry of seed germination and development, biochemistry of fruit ripening, phytohormones and their mode of action, signal transduction. Biochemistry and significance of secondary metabolites- cyanogenic glycosides, glucosinolates, phenolic compounds, terpenoids, alkaloids and plant defense system.

Biochem. 509 Animal Biochemistry 3+0 Sem. II

Digestion and absorption of food, vitamins 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. Hormones of thyroid, hypothalamus, pituitary, pancreas, adrenals and sex hormones. Membrane receptors of hormones signal transduction, biochemistry of reproduction.

Biochem. 510 Food and Nutritional Biochemistry 2+1 Sem. I

Fundamentals of human nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains (including cereals, pulses, and oilseeds), fruits and vegetables. 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, nutraceuticals, anti-nutritional factors, biochemistry of post-harvest storage. Enzymes in food industry. Effect of cooking, processing and preservation of different food products on nutrients, biochemical aspects of food spoilage, role of lipase and lipoxygenase, oxidative rancidity and antioxidants. Food additives (coloring agents, preservatives etc.), biogenesis of food flavors and aroma, nutritional quality of plant, dairy, poultry and marine products.

Practical: Estimation of starch, lipid/oil, phenols in plant tissue/sample. Estimation of carotenoid. Estimation of trypsin and chymotrypsin inhibitor activities in seeds. Estimation of Vitamin C in fruits. Reducing and non-reducing sugar in fruits. Estimation of protein contents. Estimation of dietary fiber. Determination of limiting amino acids. Estimation of phytate /oxalate.

Biochem. 601 Advanced Enzymology 3+0 Sem. II

Theory of enzymatic catalysis, specificity, concept of active site and enzyme substrate complex, different approaches for determining active site amino acids, active site mapping, acid-base and covalent catalysis, factors associated with catalytic efficiency, proximity and orientation,

distortion and strain, induced fit hypothesis, mechanism of enzyme reactions. Effect of different factors affecting enzyme activity, transition state theory, enzyme purification, Arrhenius equation, determination of energy of activation, kinetics of pH and temperature and determination of pKa and $\triangle H_{ion}$ of active site amino acids, Kinetics of bi-substrate reactions, product inhibition and use of competitive inhibitors in the study of substrate binding order. Mechanism determination by radioisotope exchange, kinetics of mixed inhibitions, substrate and product inhibition. Role of enzymes in regulation of metabolism, allosteric enzymes and their kinetics, enzyme engineering, Bi-functional enzymes.

Biochem. 602 Advanced Molecular Biochemistry 3+0 Sem. II
Anatomy of A, B and Z-DNA, alternatives DNA conformations, organization of prokaryotic genome, nuclear and organelle genes, DNA binding proteins, concept of genome mapping, molecular evolution, cell development and differentiation. Prokaryotic and eukaryotic gene regulation, RNA editing, molecular biology of viruses. Methods of gene isolation and transfer in plants and animals/commercial crop, molecular basis of male sterility. Application of genetic engineering in different fields. Site directed mutagenesis, gene targeting and gene therapy, bioethics and biosafety guidelines and IPR in recombinant DNA research.

Biochem. 603 Biochemistry of Biotic and Abiotic Stress 3+0 Sem. I
Plant-pathogen interaction and disease development; molecular mechanisms of fungal and bacterial infection in plants; changes in metabolism, cell wall composition and vascular transport in diseased plants. Plant defense response, antimicrobial molecules; genes for resistance, hypersensitive response and cell death; systemic and acquired resistance. Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination; viroids, pathogen-derived resistance. Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance, interaction between biotic and abiotic stresses; stress adaptation. Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

Biochem. 604 Current Topics in Biochemistry 2+0 Sem. II
Advanced topics related to nutrition, metabolism, enzymology, industrial biochemistry, molecular biochemistry, immunology, signal transduction, metabolic engineering and bioprospecting. Any other advance topic of current interest.

Biochem. 605 Genomics, Proteomics and Metabolomics 3+0 Sem. I
Protein and nucleic acid sequencing, various methods of sequencing including automated sequencing and microarrays, whole genome sequencing analysis Comparative genomics, functional genomics, transcriptomics, gene identification, gene annotation, pair- wise and multiple alignments, application of genomics, quantitative PCR, SAGE, MPSS, microarray analysis. Proteome technology 2 D- PAGE, MSMS, MALDI-TOF, protein microarray, comparative proteomics and structural proteomics. Metabolic pathway engineering, vitamin A engineering in cereals, role of bioinformatics in functional genomics.

Biochem. 591 Seminar

Biochem. 600 Master's Research

Biochem. 700 Ph.D. Research

BOTANY

PROGRAMMES

M.Sc.

Ph.D.

Five Year Integrated M.Sc. (Hons)

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Plant Physiology, Biosystematics
Required Courses	Bot. 501, Bot. 502, Bot. 503, Bot. 504, Bot. 505
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Biochemistry, Biotechnology, Horticulture, Microbiology, Plant Breeding and Genetics, Plant Pathology, Vegetable Crops or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Plant Physiology, Biosystematics
Required Courses	Bot. 601, Bot. 602
Supporting Courses	Courses from subject matter fields/other than Minor relating to area of special interest and research problem.
Minor Fields	Biochemistry, Biotechnology, Horticulture, Microbiology, Plant Breeding and Genetics, Plant Pathology, Vegetable Crops or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduate Studies

Five Year Integrated M.Sc. (Hons)

Field of Specialization	Plant Physiology, Biosystematics
Required Courses	All courses listed for Semester I to VI (P-____*) and Bot. 501, Bot. 502, Bot. 503, Bot. 504, Bot. 505, Bot. 591.
Supporting Courses	Stat.421 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Biochemistry, Biotechnology, Horticulture, Microbiology, Plant Breeding and Genetics, Plant Pathology, Vegetable Crops or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduate Studies.

* Page number according to new RBI.

DESCRIPTION OF COURSE CONTENTS

Undergraduate courses/Integrated M.Sc. (Hons)

Bot. 51 Agricultural Botany 1+1 Sem. I

An introduction to plant kingdom. Morphological features of a flowering plant. Structure of root and stem and their various modifications. Parts of leaf, simple and compound leaf, phyllotaxy, venation and modifications of leaf. Types of inflorescence and fruits. Reproductive system in flowering plants- flower morphology, pollination and double fertilization. Structure of monocot and dicot seed. Types of seed germination. Characteristic features and economic importance of families- Brassicaceae, Cucurbitaceae, Papilionaceae, Malvaceae, Rutaceae, Solanaceae and Poaceae. A brief account of interaction of plants with environment.

Practical: Study of one specimen from each group of plant kingdom. Morphology of root and stem and their modifications. Parts of leaf, types of leaf, phyllotaxy, venation and modifications of leaf. Racemose, cymose and special types of inflorescence. Different types of fruits. Structure of monocot and dicot seed. Epigeal and hypogeal germination. Study of one specimen from each of the above mentioned families

Bot. 91 Basic Plant Physiology 3+1 Sem. II

Plant water relations-diffusion, imbibition, osmosis, plasmolysis, water potential; transport in plants: movement of water, gases and nutrients; cell to cell transport- diffusion, facilitated diffusion, active transport long distance transport of water- absorption, apoplast, symplast, transpiration pull, root pressure and guttation; opening and closing of stomata uptake and translocation of mineral nutrients; transport of food; phloem transport, mass flow hypothesis mineral nutrition- essential minerals, macro and micronutrients and their role; deficiency symptoms; mineral toxicity; elementary idea of hydroponics as a method to study mineral nutrition nitrogen metabolism- nitrogen cycle, biological nitrogen fixation photosynthesis- site of photosynthesis, pigments involved in photosynthesis (elementary idea); photochemical (cyclic and non cyclic photophosphorylation) and biosynthetic phases (C_3, C_4 and CAM pathways) of photosynthesis, factors affecting photosynthesis respiration- exchange of gases; cellular respiration - glycolysis, fermentation (anaerobic),TCA cycle and electron transport system (aerobic); energy relations - number of ATP molecules generated; respiratory quotient. Plant growth and development- phases of plant growth and plant growth rate; conditions of growth; differentiation, dedifferentiation and redifferentiation; seed germination; factors affecting germination and seed dormancy, types of dormancy and factors affecting it phytohormones- auxin, gibberellin, cytokinin, ethylene, ABA, brief account of senescence, photoperiodism and vernalization

Practical: Study of processes of diffusion, osmosis, imbibition and plasmolysis. Measurement of water status of root, stem and leaf. Demonstration of phenomenon of transpiration. Study of distribution of stomata in upper and lower surface of leaves. Comparative study of the rate of transpiration in upper and lower surface of leaves. Study of role of factors affecting photosynthesis. Study of aerobic and anaerobic respiration. Study of mineral deficiency symptoms in various field crops. Study of seedling growth pattern.Study of seed germination and dormancy. Physiological applications of phytohormones

Bot. 92 Plant Reproduction and Biotechnology 3+1 Sem. II

Modes of reproduction- asexual and sexual, binary fission, sporulation, budding, fragmentation, vegetative propagation Sexual reproduction in flowering plants Development of male and female gametophytes; Pollination-types, agencies and examples; Outbreeding devices; pollen-pistil interaction. Double fertilization; Post fertilization events- development of embryo and endosperm Development of seed and fruit formation and significance of seed and fruit formation. Special modes-apomixis, parthenocarpy, polyembryony. Principles and process of biotechnology; Genetic engineering (recombinant DNA technology) Application of biotechnology in agriculture; Gene therapy; Genetically modified organisms- Bt crops;

Biosafety issues- biopiracy and patents.
Practical: Exercise on controlled pollination- emasculation, tagging and bagging. Study of pollen grains of different plants by making slides. Comparative study of various flowers adapted to pollination by different agencies (wind, insects)

Bot. 101 Basic Botany 2+1 Sem. I

Plant kingdom and features of each group; Morphology, modifications and functions of root, stem, leaf, flower and inflorescence; Pollination and fertilization; Fruit types; Structure of dicot and monocot seed, seed germination. Cell structure; DNA, chromosome and genes; Cell and tissue types; Internal structure of root, stem and leaf. Plant taxonomy, systems of classification; Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.
Practical: Description of one plant species from each group of plant kingdom; Study of morphology and modifications of root, stem, leaf, flower; Types of inflorescence; Structure of various types of seeds and fruits; Demonstration of cell structure, tissue types; Structure of monocot and dicot root, stem and leaf; One flower from each family.

Bot. 104 Fundamentals of Crop Physiology 1+1 Sem. II

Introduction to crop physiology and its importance in agriculture. Plant cell-an overview. Diffusion and osmosis, absorption of water, transpiration and stomatal physiology. Mineral nutrition of plants-functions and deficiency symptoms of nutrients, nutrient uptake mechanisms. Photosynthesis-light and dark reactions, C_3, C_4 and CAM plants. Respiration-glycolysis, TCA cycle and electron transport chain. Fat Metabolism-fatty acid synthesis and breakdown. Plant growth regulators- physiological roles and agricultural uses. Physiological aspects of growth and development of major crops. Growth analysis, role of physiological growth parameters in crop productivity.
Practical: Study of plant cells. Structure and distribution of stomata, imbibition, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, estimation of tissue relative water content. Separation of photosynthetic pigments through paper chromatography, demonstration of rates of photosynthesis and respiration. Tissue test for estimation of mineral nutrients, demonstration of deficiency symptoms of mineral nutrients in plants.

Bot. 201 Plant Physiology 2+1 Sem. I

Plant physiology- scope in agriculture. Osmosis, imbibition, water absorption, water translocation and transpiration. Stomatal mechanisms. Physiological role and deficiency symptoms of major and minor elements. Absorption and translocation of minerals. Concepts of photosynthesis, photorespiration and translocation of photoassimilates. Respiration. Dynamics of growth. Stress physiology. Nitrogen and sulphur metabolism. Plant growth regulators - biosynthesis and physiological roles. Seed germination and dormancy. Senescence and abscission. Vernalization.
Practical: Demonstration of processes of diffusion, osmosis, imbibition and plasmolysis. Ascent of sap, transpiration. Nutrient deficiency symptoms in crop plants. Plant growth analysis. Quantitative and qualitative estimation of plant pigments. Experiments on photosynthesis and respiration. Effects of plant growth regulators on growth and seed germination. Experiments on seed dormancy. Estimation of relative water content and plant water potential. Proline estimation.

Bot. 202 Plant Morphology 3+0 Sem. I

Morphology, modifications and functions of root, stem and leaf. Inflorescence types, definition of flower, origin of floral leaves, tendencies in the evolution of the flower, floral anatomy of dicot and monocot flower, morphology of calyx and corolla, structure and morphological nature of stamen, staminodes; morphology of the carpel; vasculature and interpretation of inferior ovary; types of placentation; form, orientation and the nature of ovule; evolutionary

relationship of fruit types; detailed morphology of important crop plants: cereals, pulses, fibre crops and oilseeds.

Bot. 203 Systematic Botany 3+0 Sem. II

History of plant taxonomy, modern systems of classification; principles of taxonomy; International rules of nomenclature; botanical gardens and herbaria; General account of floral variation, evolutionary affinities and economic importance of representative families of various orders of the series: Thalamiflorae, Disciflorae, Calyciflorae, Inferae, Heteromerae, Curvembryeae, Multiovulatae aquaticae, Multiovulatae terrestris, Microembryeae, Daphnales, Achlamydosporeae, Unisexuales and Ordines anomali. Evolution of families from the series: Microspermae, Epigynae, Coronarieae, Calycinae, Nudiflorae, Apocarpeae and Glumaceae.

Bot. 204 Plant Histology 2+0 Sem. I

Ultrastructure of cell and its inclusions; cell wall organization and its growth; tissues and tissue systems; shoot and root apical meristems and vascular cambium; anatomy of root, stem, leaf and flower; secondary growth and anomalous secondary growth; distribution of mechanical tissues in plants; galls and tumours; applications of plant anatomy.

Bot. 205 Botany of Economic Plants 2+0 Sem. I

Recent trends and scope of economic botany; Botanical description and commercial products of major categories of food plants (cereals, millets, pulses, nuts, vegetables and fruits) , sugar producing plants, oils (essential and edible oils, fatty oils), beverage-, fibres-, latex- (rubber and other latex products), paper and medicinal plants (drugs obtained from various plant parts), biofuels.

Bot. 301 Fundamentals of Plant Physiology 3+0 Sem. II

Plant physiology, its scope in agriculture. Structure and functions of cell organelles; osmosis, imbibition, water potential and its components,water absorption, water translocation and transpiration; stomatal mechanisms; source, physiological roles and deficiency symptoms of major and minor elements, absorption and translocation of minerals and cell sap; concepts of photosynthesis and respiration, photorespiration, water culture technique; processes involved in growth and development; plant growth regulators: occurrence, biosynthesis, mode of action and commercial applications

Bot. 302 Basic Experiments in Botany 0+3 Sem. I

Description of plant species from each family in technical terms, study of morphology of different plant parts viz., root, stem and leaf; floral biology of important plants; study of cells and tissues by hand sectioning and maceration; study of anatomical structures in longitudinal and transverse sections of root, stem and leaf. Study of cell, cytoplasm and nucleus; demonstration of processes of osmosis, imbibition, plasmolysis; role of factors affecting photosynthesis and respiration; deficiency symptoms of nutrients in crop plants; processes involved in growth and development.

Bot. 303 Algae, Fungi and Lichens 2+1 Sem. I

Introduction, classification, comparative morphology, reproduction, perennation; economic importance; interrelationships and evolutionary tendencies of algae; structure, reproduction and life cycle of algal species belonging to the different groups viz., Cyanophyta, Chlorophyta, Xanthophyta, Chrysophyta, Euglenophyta, Phaeophyta and Rhodophyta. Nomenclature and classification of fungi belonging to classes Phycomycetes, Ascomycetes, Basidiomycetes and Fungi Imperfecti; general characteristics and life cycles of important genera of fungi and lichens.

Practical: Study of the morphology of different algae and fungi, monographic study of some important algae and fungi.

Bot. 304 Bryophyta **2+1** **Sem. II**

Introduction, classification, origin and economic importance of bryophytes, their ecology and distribution. Hepaticeae and Anthocerotae: General characters and classification, gametophytes of thalloid and leafy liverworts. Asexual reproduction, sporophytes of liverworts. General account of Anthocerotae and their evolutionary tendencies. Musci: General characters and classification, range of gametophyte structure, asexual and sexual reproduction, sporophyte and alternation of generation; origin and evolution of sporophyte; geographical distribution; cytogenetics and speciation.

Practical: Study of representative types belonging to different groups.

Bot. 305 Pteridophyta **2+1** **Sem. II**

Introduction; general features; classification; life cycle and alternation of generation; salient features of different groups like Psilophyta, Lycophyta, Sphenophyta and Pterophyta. Study of life histories of following important genera e.g. *Selaginella, Psilotum, Lycopodium, Isoetes, Equisetum, Ophioglossum, Dryopteris, Marsilea, Azolla* and *Salvinia*. Origin of Pteridophyta, apogamy and apospory; stelar system, telome theory and evolution of sporophyte; heterospory and seed habit, gametophytes of pteriodophytes; fossil pteriodophytes.

Practical: Study of representative types belonging to different groups.

Bot. 306 Gymnosperms **2+1** **Sem. II**

General description; Differences between gymnosperms, higher cryptogams and angiosperms; classification of gymnosperms; detailed study and life cycle of *Gingko, Cycas, Biota, Pinus, Ephedra, Gnetum, Welwitschia, Juniperus* and *Cupressus*; process of fossilization.

Practical: Study of morphology, anatomy and reproduction of important genera pertaining to above. Examination of fossil slides.

Bot. 307 Plant Biodiversity and Environment **2+1** **Sem. I**

Concepts of biodiversity, conservation and protection of biodiversity for its suitable utilization; agro-biodiversity and its missions. Diversification of cropping system; introduction of herbal crops in Punjab; vulnerability and extinction of species; endangered species in various ecosystems; use of plant species to check deforestation and desertification; germplasm banks. Response of plants to environmental stresses, greenhouse effect, environmental pollution, pollution of soil and water bodies

Practical: Plant survey methods; excursions and field visits. Effect of environmental factors on plant growth, assimilation rate and biomass partitioning.

Bot. 401 Plant Physiology-I (Plant Water Relations and Mineral Nutrition) **2+1** **Sem. II**

Plant cell, membranes, cell organelles; properties of water; osmotic potential, water potential, pressure potential and their relationships; soil water, absorption and translocation of water; plasmolysis, imbibition, stomatal mechanisms, factors affecting water loss, wilting, drought resistance; essential elements: physiological functions and deficiency symptoms of macro and microelements. Mechanism of mineral absorption, factors affecting mineral absorption; microorganisms in relation to nutrient acquisition, nutrient use efficiency. Nutrients in metabolism and disease tolerance.

Practical: Cell structure; preparation of solutions. Demonstrations of processes of diffusion, osmosis, imbibition and plasmolysis; measurements of water potential, membrane permeability, root pressure, guttation, ascent of water, transpiration.; deficiency symptoms of nutrients in crop plants; phloem mobility; cation exchange capacity in plant species.

Bot. 402 Plant Physiology-II (Plant Metabolism) **2+1** **Sem. II**

Photosynthesis; plant pigments, photosystems, light and dark reactions in C3, C4 and CAM plants; respiration, glycolysis, pentose phosphate pathway, citric acid cycle, electron transport chain; photorespiration and its significance in plant productivity; secondary metabolites and plant defense systems.
Practical: Characterization of pigments; determination of Hill reaction activity; experiments on photosynthesis and respiration.

Bot. 403 Plant Physiology-III (Growth, Differentiation and Morphogenesis) **2+1** **Sem. II**

Mechanics of growth and differentiation in plants; factors affecting growth and differentiation; Plant growth regulators (growth promoters, inhibitors and retardants); photoperiodism and vernalization; physiology of seed formation, maturation, dormancy and germination; fruit ripening. Senescence and programmed cell death. Brief account of morphogenesis; polarity, symmetry, regeneration, tissue culture and abnormal growth. Effect of light, water, temperature and growth on morphogenesis.
Practical: Sigmoid growth curve, bioassays of plant growth regulators, their effects on seed germination and plant growth. Experiments on seed dormancy, senescence and fruit ripening.

Undergraduate /M.Sc. Supporting /Minor Courses

Bot. 421 Water Relations and Mineral Nutrition **2+1** **Sem. I**

Plant cell, membranes, cell organelles, their structure and function; properties of water; osmotic potential, water potential, pressure potential and their relationship; plasmolysis, imbibition; absorption and translocation of water; stomata, stomatal mechanism, factors affecting water loss, drought resistance -physiological and molecular basis, essential elements,deficiency symptoms; physiological roles and deficiency diseases; mineral absorption and translocation. Ion uptake, microorganisms in relation to nutrient acquisition, uptake by roots;; nitrogen metabolism - proteins, nucleic acids and enzymes; yield and mineral nutrition, nutrient use efficiency; molecular aspects of nutrient uptake and transport.
Practical: Cell structure; preparation of solutions, diffusion, osmosis, imbibition, plasmolysis, measurements of ψ_w and ψ_s ; membrane permeability, root pressure, guttation, ascent of water, transpiration experiments; deficiency and toxicity symptoms of nutrients in crop plants; demonstration of ion channels; phloem mobility of various nutrients; estimation of ferrous ions in leaves; plant analysis for N, P and S; cation exchange capacity in plant species; catalase, peroxidase and nitrate reductase activities as indicators of nutrient status of a crop; effect of toxic elements on germination and growth of seedlings.

Bot. 422 Photosynthesis, Respiration and Metabolism **2+1** **Sem. I & II**

Photosynthesis: history, structure of chloroplast, pigments; principles of light absorption by chloroplast, photosystems, photophosphorylation, ATP synthesis; CO_2 fixation and reduction, carbohydrate synthesis, C_3, C_4 and CAM plants; translocation of metabolites; photorespiration - its mechanism and significance in plant productivity; environmental and agricultural aspects of photosynthesis, photosynthetic efficiency, source-sink relationships and productivity. Respiration: history, mitochondria structure, glycolysis, Krebs cycle, oxidative phosphorylation, cyanide resistant respiration, climacteric and salt induced respiration; energy relationship of aerobic and anaerobic respiration; pentose phosphate pathway, anaerobic respiration; metabolism of lipids and other natural products; fats and oil, phenolic compounds, phytoalexins, lignin, flavonoids, betalains, alkaloids, waxes, cutin and suberin.
Practical: Experiments related to photosynthesis; chlorophyll and other pigment determinations, Hill reaction activity; anatomical characterization of C_3, C_4 and CAM plants. Experiments related to respiration; respiratory quotient; determination of sugar, starch and

proteins.

Bot. 423 Physiology of Growth and Development 2+1 Sem. I

Concepts of growth, differentiation and pattern formation; growth curves, meristems, growth kinetics, factors affecting growth and general aspects of development, level of differentiation, control of development at genetic level. Hormones and growth regulators - auxins, gibberellins, cytokinins, ethylene, ABA, other inhibitors, retardants, polyamines, aliphatic alcohols, brassins, hormonal regulation of growth and development, plant movements; photoperiodism, phytochrome, flowering hormones, vernalization, abscission, ageing, senescence; physiology of seed and fruit development; seed germination; seed and bud dormancy. Plant physiology and agriculture

Practical: Experiments on growth measurements, hormonal bioassays, plant movements; experiments on quality of light on seed germination, breaking of dormancy. Experiments on photoperiodism. Experiments on hormonal regulation of development.

Bot. 424 Plant Anatomy 2+1 Sem. II

Cell structure, cell wall, meristems; tissues and tissue systems; primary and secondary xylem and phloem; vascular cambium; periderm; internal structure of monocot and dicot root, stem, leaf, fruit and seed; secondary growth - normal and anomalous; storage region in root and tuber crops; origin of lateral and adventitious roots; healing of wounds, grafting and abscission; ecological anatomy; leaf anatomy of C3, C4 and CAM plants.

Practical: Cell structure, cell wall - permanent slides and slide preparation; simple and double staining to study different types of simple and permanent tissues, leaf, root, stem, fruit and seed; study of normal and anomalous secondary growth; anatomy of representative storage roots and tuberous crops.

Bot. 425 Taxonomy of Angiosperms 2+1 Sem. I

History of plant taxonomy; modern systems of classification; principles of taxonomy, modern trends in plant classification; chemotaxonomy; numerical taxonomy; international rules of nomenclature; relationships of experimental and orthodox taxonomy; taxonomy in relation to anatomy, cytology, palynology, embryology and chemistry. General account of floral variations, evolutionary affinity and economic importance of families-Ranunculaceae, Papaveraceae, Brassicaceae, Malvaceae, Rutaceae, Caesalpinaceae, Mimosaceae, Rosaceae, Scrophulariaceae, Chenopodiaceae, Euphorbiaceae, Solanaceae, Cucurbitaceae, Papilionaceae, Liliaceae, Amaryllidaceae, Cyperaceae and Poaceae.

Practical: Technical terms and symbols used in description of plants and descriptive procedure for taxonomic studies, detailed study of taxonomic features of at least one plant belonging to above families. Demonstration of various herbarium techniques and collection of local flora.

Bot. 426 Morphology of Crop Plants 2+1 Sem. II

General morphology and origin of important crop plants, i.e. wheat, rice, maize, cotton, groundnut, mustard, sunflower, sugarcane, potato and pulses; vegetative and reproductive growth of these plants with emphasis on their floral biology, mode of reproduction, seed formation and economic importance.

Practical: Study of morphology and floral biology of the above crop plants.

Postgraduate Courses

Bot. 501 Cellular and Developmental Plant Physiology 3+1 Sem. I

Structure and physiological functions of plant cell and cell inclusions; mechanism of water uptake, aquaporins, transpiration, stomata structure, stomatal movement, antitranspirants; mineral elements, their role in plant metabolism; transport proteins; mechanism of uptake and translocation of minerals in plants, nutrient deficiency and toxicity; N, P and S metabolism;

photosynthesis, its importance in bioproductivity, photochemical reactions, CO2 fixation in C3, C4 and CAM plants, photorespiration, carbohydrate synthesis, translocation of photosynthates and source-sink relationship; mitochondrial respiration, ATP synthesis, cyanide resistant respiration; plant growth regulators, their biosynthesis, mechanism of action and their role in agriculture; regulation of growth and development; physiology and biochemistry of seed dormancy and seed germination; photomorphogenesis, photoreceptors, photoperiodism; vernalization; senescence and abscission; fruit growth and ripening; biotic and abiotic stresses (drought, flooding, salinity , high and low temperature, anoxic and radiation) affecting plant metabolism and growth; signal transduction in plants cells.
Practical: Measurement of plant water status; determination of water potential and its components; physiological role and deficiency symptoms of macro- and micro-elements; characterization of plastids; pigments; determination of Hill reaction activity; experiments demonstrating involvement of ion channels in ion uptake and calcium in signal transduction; sigmoid growth at organ and whole plant level; bioassays to demonstrate the occurrence of plant hormones; experiments demonstrating physiological effects of PGRs; experiments on tropism, seed dormancy, germination, senescence and fruit ripening.

Bot. 502 Plant Anatomy and Embryology 2+1 Sem. I

Modular, tissue and cellular organization of plant body; differentiation, totipotency and morphogenesis; ultrastructure of plant cell, development of cell wall; tissues - their ontogeny in relation to functional specialization, transfer cells; meristems; structure and development of stem, root and leaf, stomata and secretory tissues; origin of cambium, unusual secondary growth, structure of flower, mega and microsporogenesis, pollen plstil interactions, fertilization, embryo development, polyembryony, parthenogenesis, parthenocarpy, abscission, healing of wounds and union of grafts; application of applied plant anatomy and embryology in crop improvement.
Practical: Study of structure of parenchyma, collenchyma, sclerenchyma, xylem and phloem, transfer cells, laticifers, stomata, epidermal glands; structure and organization of shoot apex and root apex; origin of procambium and cambium; secondary growth and anamolous seconday growth; variations in organization in stem, root and leaf.

Bot. 503 Taxonomy and Biosystematics 2+1 Sem. I

Principles of taxonomy as applied to systematics and classification of plant kingdom; plasticity of phenotype, phenotypic variability; plant geography; sympatric and allopatric taxa; primary and secondary centres of origin; adaptive radiations; abrupt and general speciation mechanisms; speciation in vegetatively reproducing plants; ecological properties of a species; pattern of ecotypic differentiation; structural, biochemical and molecular systematics; modern systems of classification; numerical taxonomy; herbaria- field and herbarium techniques; botanical gardens; floristics and botanical survey of India; taxonomic structure; floristics ; diagnostic features and economic importance of important families. origin and evolution of economically important plants; plants and civilization; centres of origin and gene diversity; botany, utilization, cultivation and improvement of plants of food, drug, fibre and industrial use; unexploited plants of potential economic value; plants as a source of renewable energy.
Practical: Description of families (Magnoliaceae; Papaveraceae; Brassicaceae; Malvaceae; Rutaceae; Meliaceae; Fabaceae; Rosaceae; Myrtaceae; Cucurbitaceae; Apiaceae; Rubiaceae; Asteraceae (Compositae); Solanaceae; Scrophulariaceae; Lamiaceae; Chenopodiaceae; Euphorbiaceae; Orchidaceae; Musaceae; Zingiberaceae; Amaryllidaceae; Liliaceae; Arecaceae; Araceae; Cyperaceae and Poaceae) collection of plants and preparation of herbarium; identification of economic plants and plant products. Excursions and field visits.

Bot. 504 Plant Ecology 2+1 Sem. II

Concepts of ecology, autecology, synecology; concepts and dynamics of ecosystems, types of ecosystem; components of food chains and energy flow; succession, management and ecological pyramids; community structure and dynamics, biogeochemical cycling, climate and vegetation of India; ecological adaptations; environment pollution, environmental monitoring, environment impact assessment, sustainable development, remote sensing of ecological research, economic importance of microbes, plants and animals.
Practical: Experiments on community structure and dynamics, floristic composition; succession. Experiments on pollution, remote sensing of agricultural and ecological systems.

Bot. 505 Plant Biotechnology 2+0 Sem. II
Principles and methods of genetic engineering of plants with particular reference to photosynthesis, nitrogen fixation and seed proteins; rapid plant propagation by tissue culture; cell lines; cell clones; in vitro approaches to the genetic manipulation of plants; blotting technique; polymerase chain reaction, protoplast fusion, somatic hybridization; hybrid and cybrid production; haploid plant production; somatic embryogenesis and artificial seeds; hybridoma technology; allopheny; pre-fertilization treatments of pollen for directed genetic change; in vitro manipulation of ovule tissues; germplasm maintenance and storage; growth regulators in relation to plant productivity; Prospects of Plant Biotechnology in crop improvement; molecular farming; molecular probes; omics technologies and their applications.

Bot. 506 Histochemistry and Plant Ultrastructure 1+1 Sem. II
Histochemistry and cytochemistry - principles; botanical microtechniques; stains and staining procedures; microscopy - principles of light and electron microscopes; microscopic measurements; general structure, importance and histochemical procedures for localization of reserve substances like polysaccharides, lipids, proteins, nucleic acids and some important enzymes in plant tissues; histochemical analysis of some plant processes like abscission, reproductive development, stomatal movement, etc. Ultrastructure of plant cell membrane, cell wall, nucleus and some organelles; endoplasmic reticulum; lysosomes; ultrastructure of meristematic cells; phloem, cambium, guard cells, embryosac, etc.; role of histochemistry in collation of structure with function.
Practical: Processing of plant material for microtome sectioning and preparation of slides; histochemical localization of reserve substances and enzymes in plant cells/tissues in hand sections and microtome sections.

Bot. 507 Plant Biodiversity and Environmental Conservation 1+1 Sem. I
Agrobiodiversity, its missions and concerns; conservation and protection of biodiversity for its sustainable utilization; multipurpose tree management; diversification of cropping system; introduction of herbal crops in Punjab; vulnerability and extinction of species; distribution and ecology of endangered species in various ecosystems; use of plant species to check deforestation, desertification and pollution of water bodies; germplasm banks.
Practical: Plant survey methods; plant diversity at PAU campus, diversity in medicinal herbs, shrubs and trees, diversity in ornamental and field visits.

Bot. 508 Plant Morphogenesis 2+1 Sem. II
Organization of structure and function at molecular, cellular, tissue, organ and whole plant level, cellular polarity and regulation of cell and tissue dimension, pattern formation and cellular differentiation, organization of shoot apical meristem, leaf development and differentiation, root apical meristem, root hair, stomata and trichome development, floral development and differentiation, seed and fruit development; Organogenesis of root, stem, leaf, flower, fruit, and seed. Totipotency; apical dominance and phase change; biochemical, physiological and hormonal plant mutants, hormones, agonists; elements of cellular transduction in relation to differentiation in plants; programmed cell death;

photomorphogenesis; in vitro regulation of differentiation and development in higher plants.
Practical: Effect of light, temperature and plant growth regulators on cellular differentiation and organogenesis.

Bot. 509 Environmental and Stress Physiology 2+1 Sem. II

Principles of environmental physiology; Response of plants to abiotic stresses and its effect on productivity; interactions between biotic and abiotic stresses; plant responses to freezing, chilling and high temperature- role of membrane lipids, HSP's; drought, osmoprotectants, water use efficiency as drought resistant trait; soil salinity, species variation to salt tolerance, flooding and anaerobiosis; radiation stress; air and water pollutants; green house effects at cellular and whole plant levels; heavy metal stress; physiological and molecular mechanisms to combat stresses by plants; stress and hormones, ABA as signaling molecule; cytokinin as a negative signal, oxidative stress and role of reactive oxygen species (ROS) scavenging system (SOD and Catalase etc); basic principles of crop improvement programmes under stress. mineral cycling and energy transfer in biotic and abiotic components; mutualism, competition, allelopathy; crop- land ecosystem.
Practical: Laboratory and field experiments on the effect of abiotic stresses, e.g. water high temperature salinity, heavy metal toxicity, pollutants, radiation; estimation of free fatty acids level, membrane integrity; and proline content in relation to abiotic stresses, estimation of nitrates in irrigation waters, allelopathy and composition in agri-ecosystems.

Bot. 510 Growth Regulators 2+1 Sem. II

Plant growth regulators; definition, classification, biosynthesis, transport, metabolism, physiological role and mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines, phenols, salicylic acid, triacontanol, brassinolides, jasmonic acid; concept of death hormone - nitric oxide, etc.; inhibitors, retardants, synthetic growth regulators and their practical utility in agriculture and horticulture; concept of second messengers; hormone receptors; pathways of signal transduction associated with plant hormones; hormone mutants and transgenic plants in relation to hormone action; hormonal regulation of gene expression; application of hormones in rooting of cuttings, apical dominance, flowering and fruit development.
Practical: Bioassasys, effects and mechanism of action of growth regulators; demonstration of hormonal mediated signal transduction.

Bot. 601 Advances in Botany 3+0 Sem. II

Plant development- new perspectives, molecular and hormonal coordination of plant development; recent development in control of phyllotaxic patterns of plants; programmed cell death; secretary tissues in plants; applications of plant anatomy in structure -function correlations; impact of environmental pollution on plant structure; plant defense mechanism in disease resistance; epicuticular waxes and role in stress tolerance; phytoremediation; phytoextraction of toxic metals; molecular mechanisms of roots nodule development; nitrogen fixation by legumes in tropical and sub- tropical crops; biofertilizers; long-distance signaling to control root nodule number and role of flavonoids; recent development in plant tropism: providing the power of movement to sessile organisms; membrane traffic within the golgi apparatus and intra-golgi cargo transport; COPI vesicles as long distance carriers; alkaloid biosynthesis- histochemisrty and metabolism; crop simulation models in agriculture; mechanism of carnivorous nutrition in higher plants; retrograde signaling in plants: from plastid to nucleus; weed biology, ecology and physiology, weed and crop competition, allelochemicals their nature and impact, weed- seed physiology; application of nanotechnology in agriculture.

Bot. 602 Advances in Plant Physiology 3+0 Sem. II

Recent advances in plant physiology and molecular biology; plant hormones and their role in

integration of growth and development; hormones receptors, transduction process, effector molecules and gene expression; hormone action mutants, elements of signaling pathways and mechanism of signal transduction; two components sensing system; cross talk in the signaling of different hormones; calcium a silver bullet in signaling and regulation of metabolism; abiotic stress signaling, case studies with different stresses; transgenic approaches in improving physiological processes; importance of mutants in unraveling physiological processes; molecular aspects of nutrient uptake and transport, nutrient sensing and signaling; ABC- transporters; conventional and biotechnological approaches to improve yield potential and quality ofcrop plants. New emerging technologies and their scope in crop improvement; scope of plant physiology in the era of second green revolution.

Bot. 603 Advances in Reproductive Biology **2+0** **Sem. I**

Introduction; approaches to study mechanisms of reproductive development; cell determination and cell interactions in reproductive meristems; floral induction, physiological signals and multi-factorial system of control of floral metamorphosis; ABC model for floral organ specifications; development of egg cell and its role in fertilization; suspensor and its importance in embryo development; endosperm origin, development and functions; molecular basis of microsporogenesis; Self-incompatibility mechanisms; mutations affecting gametophyte development; regulation of pollen viability, germination and tube growth; pollen-pistil interactions, new concepts of recognition in plants; seed development, deposition of storage reserves, embryo maturation and desiccation; cytoplasmic male sterility and hybrid seed production; fruit development, fruit ripening and role of fruit wall in seed development; physiological and molecular aspects of fruit ripening and senescence, role of plant hormones in reproductive development; scope for genetic modification of post harvest life of flowers and fruits; mechanism of seed and fruit abortion and means to overcome it; impact of environmental factors on reproductive development in relation to productivity.

Bot. 604 Advances in Morphogenesis **2+0** **Sem. I**

Introduction, phenology of morphogenesis; cell cycle - historical perspectives, mechanism and regulation; cytokinesis in pattern formation- meristems in plant development; initiation and regulation of development pathways; hormonal regulation of developmental processes; apical dominance; abnormal plant growth- hormonal and elemental control; photomorphogensis- photoreceptors for various light regions; phytochrome and light control of plant development; blue-light mediated responses and morphogenesis; photoregulated gene expression in plants; phytochrome transgenes - their biotechnological applications; plasmodesmata-dynamics, domains and patterning and intracelluar communication through plasmodesmata; morphogenesis and molecular genetic analysis of trichome development; asymmetric cell division in plants; plasma membrane interaction with the cytoskeleton and cell wall; morphogenetic and molecular aspects of stomatal development; orientation of spacing and patterning of stomata; genetic architecture of leaf morphogenesis, model for leaf morphogenesis

Bot. 605 Molecular Approaches for Improving Physiological Traits in Crop Plants **3+0** **Sem. I**

Introduction to physiological traits relevant to growth, development and productivity, nutrient acquisition; abiotic and biotic stress tolerance; importance of mutants in nraveling important physiological processes; importance of molecular plant breeding in crop improvement; basic aspects of genomics, proteomics, and metabiomics and their potential applications; genetic markers and their comparison with conventional methods; PCR : rationale, techniques and applications; DNA- based marker systems and their applications; linkage maps and mapping populations; strategies for quantitative traits loci (QTL) introgression and marker assisted selection (MAS) for crop improvement; recombinant DNA technology: gene transfer methods; selection of transformants and their analysis using physiological / biochemical and molecular

approaches; applications of transgenics; molecular farming; issue related to biosafety and registration of genetically modified (GM) crops.

Bot. 606 Plant Responses to Climatic Change and Abiotic Stresses **2+0** **Sem. II**

Climate change and its implications; greenhouse gases and their influence on global warming and climate change; long and short-term projections of climate change: effects on natural vegetations and ecosystems, crop-pest interaction, area shift, food production and supply. plant responses to freezing, chilling, heat, drought stress; role of membrane lipids in stress tolerance; function of HSP's; osmoprotectants, water use efficiency as drought resistant trait; mechanism for tolerance to salinity, heavy metals, flooding, radiation and oxidative stress; ROS and scavenging system; basic principles of crop improvement programme under stress. Approaches to mitigate climate change through studies on plant responses; direct and indirect effects of environmental stresses on plant processes: phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield; conventional and biotechnological approaches to improve the crop adaptation to climate change; relevance of "Genome wide mutants" to identify genes/processes for improved adaptation to changing environments; International conventions and global initiatives on carbon sequestration, carbon trading.

Bot. 607 Seed Physiology **2+0** **Sem. I**

Importance and structure of seeds; physiology of seed and fruit development; environmental effects on seed development: physiological and molecular aspects; seed development patterns and source of assimilates; control processes in mobilization of assimilates in developing seeds of monocots and dicots; chemical composition, biosynthesis, storage of carbohydrates, proteins and fats in seeds; gene imprints and seed and fruit abortion and means to overcome it; seed respiration; seed ageing; chemistry of oxidation of starch, protein and fats, utilization of breakdown products by embryonic axis; inception of germination: hormonal and molecular regulation of seed germination events; seed maturation and desiccation damage: role of LEA proteins; precocious seed germination; seed viability: physiological and genetic aspects to prolong viability; seed vigour: concept, importance, measurement; invigoration - methods and physiological basis: orthodox and recalcitrant seeds; types of seed dormancy, structural and chemical basis of seed coat impermeability and hard seededness; means to overcome dormancy.

Bot. 591 Seminar **Sem. I & II**

Bot. 600 Master's Research

Bot. 700 Ph. D. Research

BUSINESS STUDIES

PROGRAMMES

M.B.A.

Ph.D.

M.B.A. (Agribusiness)

COURSE REQUIREMENTS

M.B.A.

Field of Specialization	Marketing Management, Financial Management, Production Management, Human Resource Management Agribusiness Management, e-business.
Required Courses	Mgt. 501, Mgt. 502, Mgt. 503, Mgt. 504, Mgt. 505, Mgt. 506, Mgt. 507, Mgt. 508, Mgt. 509, Mgt. 510, Mgt. 511, Mgt. 512, Mgt. 513.
Supporting Courses	Stat 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Economics, Sociology, Extension Education, Statistics, Computer Science or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Financial Management, Marketing Management
Required Courses	Mgt. 601, Mgt. 602, Mgt. 695.
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Economics, Statistics, Electrical Engineering (Systems and Control) or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

M.B.A. (Agribusiness)

Field of Specialization	Agribusiness Management
Required Courses	ABM 501, ABM 502, ABM 503, ABM 504, ABM 505, ABM 506, ABM 507, ABM 508, ABM 509, ABM 510, ABM 511, ABM 512, ABM 513.
Supporting Courses	Stat 421, PGS 501 Eng 503 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Economics, Sociology, Extension Education, Statistics, Computer Science or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Mgt. 51 Introduction to Marketing Management 2+0 Sem. I

Introduction to marketing management. Marketing concepts and managerial functions of marketing. Understanding market and marketing management, segmentation targeting and positioning. Marketing mix-product, price, place and promotion. Developing marketing strategies for services. Marketing practices of selected Indian companies.

Mgt. 52 Production and Personnel Management 2+0 Sem. II

Production management-introduction, objectives and role. Production control for continuous, intermittent and project systems. Plant location and layout. Production scheduling and control. Personnel management-introduction, nature, objectives, role and scope. Functions of personnel management manpower planning, recruitment, selection, training and development, performance appraisal, motivation and morale.

Mgt. 53 Accounting and Financial Management 2+0 Sem. II

Financial accounting - meaning and principles. Accounting records and systems-journal, ledger, cash book and trial balance. Preparation of profit and loss account and balance sheet. Management accounting - meaning and scope. Marginal costing and cost volume, profit analysis. Budgeting and budgetary control systems. Financial management-meaning, objective and scope. Finance functions and forms of organization. Assessment of financial requirements for an enterprise. Sources of finance. Capital structure and cost of capital. Capital budgeting.

Mgt. 54 Entrepreneurial Development 2+0 Sem. II

Introduction to the concept of entrepreneurship, classification and types of entrepreneurs, women entrepreneurs, institution in aid of entrepreneurs. Steps for starting a small industry, site selection, selection of type of organization. Brief introduction to various functional area of enterprise management viz. finance and accounts, marketing production/operation, personnel, MIS and R&D. Problems of entrepreneurs specially problems faced by women entrepreneurs, key success factors in small scale industry.

Mgt. 201 Entrepreneurship Development and Business Management 2+1 Sem I/II

Entrepreneurship - introduction, definition, concept and importance. Factors affecting entrepreneurship. Entrepreneur – characteristics, types and functions. Steps for starting a small enterprise. Environmental scanning and opportunity identification. SWOT Analysis. Venture capital, joint ventures and public private partnerships. Government policies, programs and institutions supporting small entrepreneurs. Problems of small entrepreneurs. Management - definition, importance and functions. Planning - definition, steps, types and characteristics. Organizing - meaning, formal and informal organization. Directing – introduction to motivation, leadership and communication. Controlling - meaning, process and need. Introduction to financial management. Introduction to balance sheet and profit and loss statement. Ratio Analysis – liquidity, leverage, coverage, turnover and profitability ratios. Sources of short- and long-term funds. Introduction to project management. Project planning, formulation and report preparation. Introduction to production management. Introduction to marketing management. Introduction to international trade and WTO agreements - Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS). Business - value chain concept and stakeholders. Importance of agribusiness in Indian economy and factors

transforming Indian agribusiness. Government as a regulatory body in agribusiness. Opportunities and challenges to Indian agribusiness.
Practical: Case studies of successful entrepreneurs, analysis and discussion – assessing entrepreneurial traits, problem solving skills, managerial skills, achievement motivation and creativity. Visits to subject specific enterprises and agri-business houses and interaction with successful entrepreneurs. Formulation of project and report writing for starting a new venture – idea generation, market and demand feasibility, technical and financial feasibility and project appraisal techniques. Preparation of complete marketing plan of selected product / service.

Mgt. 202 Marketing Management and International Trade 2+0 Sem. I
Marketing Management - concept, functions and scope. Marketing mix - concept and elements. Market structure, environment and consumer buying behavior. Marketing research and marketing information systems. Market measurement and forecasting. Market segmentation, targeting and positioning. Marketing planning process. Product - policy, planning and life cycle. Product-mix, product line and new product development process. Branding, packaging and service decisions. Marketing channel decisions. Retailing, wholesaling and distribution. Pricing decisions - determination and pricing policy of milk products in organized and unorganized sectors of dairy industry. Promotion-mix decisions. Advertising - objectives, budget and message, media planning, personal selling, publicity and sales promotion. World consumption of food – patterns and type of food consumption across the globe. Salient features of international marketing, composition and direction of Indian exports, international marketing environment, and international market entry decision. Direct exports, indirect exports, licensing, joint ventures, direct investment and internationalization process, international distribution channels. WTO and world trade agreements related to food business, export trends and prospects of food products in India; Government institutions related to international food trade - APEDA, Tea Board, Spice Board, MOFPI, etc.

Mgt. 204 Business Management and Economics 2+0 Sem. II
Management - definition and principles. Management functions - planning, organizing, staffing, directing – motivation concept and Maslow's hierarchy of needs theory and controlling. Organization - structure and principles. Types of organization - formal and informal, line and staff, matrix and hybrid. Introduction to economics - definition, nature, scope, difference between microeconomics and macroeconomics. Theory of demand and supply, elasticity of demand, price and income elasticity. Markets - types and their characteristics. National income - GDP, GNP, NNP, disposable personal income, per capita income and inflation. Theory of production - production function and factors of production. Law of variable proportions and law of returns to scale. Cost - short run and long run, fixed, variable, total, average, marginal and opportunity cost. Break even analysis. Financial management - definition, scope and objectives. Different systems of accounting – financial, management and cost accounting. Human resource management - definition, objectives of manpower planning, process, sources of recruitment, process of selection. Corporate social responsibility – importance and business ethics.

Mgt. 301 Fundamentals of Entrepreneurship 2+0 Sem. II
Basic concepts of entrepreneurship: need and scope of entrepreneurship, forms of organization. Steps for starting a small business, various functional areas of business management. Finance: sources of funds. Production management: production system, site selection. Marketing: various marketing concepts, marketing mix, distribution and retail management. Introduction to other functional areas: HRM, MIS, R&D. Institutions supporting small entrepreneurs. Problems of small entrepreneurs, key success factors for small business.

Mgt. 302 Accounting and Inventory Management 2+0 Sem. I
Financial accounting: accounting principles. Accounting cycle- journal, ledger, trial balance.

Preparation of financial statements, understanding published financial statements. Cost accounting: basic concepts, classification of costs, preparation of cost sheet, cost- volume-profit analysis and its applications, use of accounting software. Inventory management: definition, costs, risks, inventory management techniques economic order quantity, re-order level, safety stock, ABC analysis, VED analysis, FSN analysis, ageing schedule etc.

Mgt. 303 Fundamentals of Agri-business Management and Entrepreneurship Development **2+0** **Sem. II**

Agri-business- meaning, definition, features and structure of agri-business (input, farm and processing sectors). Importance of agri-business in the Indian economy. Management- definitions, importance and functions. Planning- meaning, definition and process. Types of plans and characteristics of a sound plan. Introduction to organising, staffing, directing and controlling. Introduction to marketing management components of marketing mix. Project definitions. Project cycle- identification, formulation, appraisal, implementation, monitoring and evaluation. Entrepreneurship development- concept of entrepreneurship, entrepreneurial and managerial characteristics. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Procedure and constraints in setting up agro-based industries.

Mgt. 304 Agribusiness Management **2+1** **Sem. II**

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy. Distinctive features of Agribusiness Management. Agro based Industries - importance, needs, types and constraints. Institutional arrangement, procedures to set up agro based industries. Agri-value chain - understanding primary and support activities and their linkages. Business Environment: PEST &SWOT Analysis. Introduction to Management functions: Planning - definition, steps and implementation. Types of plans - purpose or mission, goals or objectives, strategies, policies, procedures, rules, programs and budget. Components of a business plan. Organization staffing, directing, leading and motivation, communications and control. Capital management and financial management of Agribusiness. Financial statement and their importance. Marketing management - segmentation, targeting & positioning. Marketing mix and strategies. Consumer behavior analysis, Product Life Cycle (PLC). Sales & distribution Management. Pricing policy and methods. Project Management - definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation.

Practical: Study of agri-input markets - seed, fertilizers, pesticides. Output markets - grains, fruits, vegetables, flowers. Product markets, retail trade, commodity trading, and value-added products. Financing institutions - cooperative, commercial banks, RRBs, NABARD. Preparations of projects and feasibility reports for agribusiness entrepreneur. Project appraisal/evaluation techniques. Case study of agro-based industries.

Mgt. 401 Fundamentals of Agribusiness Management **2+0** **Sem. II**

Nature and scope of agribusiness. Evolution and changing dimensions of agri-business in India with special reference to Punjab. Characteristics of production, consumption and marketing of agricultural surplus. Processing of agricultural output. Entrepreneurship in agribusiness. Types and patterns of organization in agribusiness. Principles of management and application in agribusiness enterprises. Locational factors and various other problems faced by agro-industrial and other enterprises related with agribusiness.

Mgt. 421 Introduction to Management and Marketing **2+0** **Sem. II**

Nature and process of management, forms of business organization, nature and process of planning. Organizing - nature, process, authority relationship, delegation of authority, centralization and decentralization, directing, communication, motivation, leadership. Controlling - nature and concept, functional areas of management, marketing management -

nature and concept, marketing decisions, marketing strategy, market segmentation and consumer purchase behavior.

Mgt. 422 Agribusiness Management and Trade 3+0 Sem. I

Management concepts: introduction, scope, theories and principles. Introduction to functions of management- planning, organizing, staffing, directing and controlling. Agribusiness-concept, agribusiness system and application of management principles to agribusiness. Production, processing, consumption and marketing of agricultural products. Problems related to processing and marketing of agricultural products in Indian context. International trade-basics, classical theory, theory of absolute advantage, theory of comparative advantage and modern theories. Free trade- protection, methods of protection including tariff and non-tariff barriers. Balance of trade and balance of payments. Introduction to GATT and WTO. World trade agreements related to food business- agreement on agriculture, aggregate measure of support, sanitary and phyto-sanitary and safeguard measures. World consumption of food-pattern and types of food consumption across the globe. Export trends and prospects of processed food in India. Management of export-import organization- registration, documentation and export-import logistics. Government institutions related to international food trade.

Mgt. 423 Introduction to Entrepreneurship and Marketing 2+1 Sem. I

Concept of entrepreneurship, entrepreneurial and managerial characteristics. Managing an enterprise. Importance of planning, monitoring and evaluation and follow-up. Generation, incubation and commercialization of ideas and innovations. Steps for starting a new venture-selection of product/ service and site selection. Sources of funds. Constraints in setting up a new venture. Preparation of project report for starting a new venture, SWOT analysis. Government schemes and incentives for promotion of entrepreneurship. Marketing management- meaning, definition, segmentation, targeting, positioning and 4P's of marketing mix. Product- product life cycle, developing new products. Pricing- meaning, steps for determining price. Introduction to channels of marketing and promotional tools.

Practical: Preparation of project report for starting a new venture. Case studies of successful entrepreneurs. Preparation of complete marketing plan of selected product/service including segmentation, targeting, positioning and various components of marketing mix such as product, price, channel and promotion.

Mgt. 424 Fundamentals of Marketing Management 2+0 Sem. I

Marketing management: meaning, significance and importance of markets and marketing. Marketing environment, marketing research, marketing mix. Segmenting, targeting and positioning. Buyer behaviour: motives and factors influencing the various stages of buying process. Product decisions: product life cycle, new product development, product planning, product mix, product line and branding decisions, packaging and labelling. Pricing decisions: methods of pricing, price adaptations. Introduction to marketing channels and promotion mix. Introduction to sales management.

Mgt. 433 Financial and Project Management 3+1 Sem. I

Importance, need, scope and functions of finance. Concept of time value of money. Capital budgeting concept and steps in capital budgeting, appraisal criteria- payback period, average rate of return, net present value, benefit cost ratio and internal rate of return. Working Capital Management- concept, determinants and need for working capital in agribusiness. Introduction, objectives and techniques of inventory management for agribusiness. Introduction to cost of capital and capital structure. Project management- concept, characteristics and types of projects. Project feasibility- market, technical, financial and economic feasibility. Project risk analysis. Estimating financial requirements of projects and sources of finance.

Practical: Case studies related to financial management and project management. Visits to agri-business industrial houses. Numerical problems based on capital budgeting. Preparation of project report for various agri-business ventures.

Mgt. 434 Retailing and Supply Chain Management 3+0 Sem. I
Introduction to retailing- definition, concept and overview. Types of retail institutions related to agri- business. Changing food consumption patterns in India. Store location and site selection. Managing retail operations procurement and inventory management. Store design- the exterior, interior, layout and display. Promoting store. Introduction to customer relationship management in retail business. Supply chain management concept, definition and importance. Elements of physical distribution systems, building and operating supply chains in agribusiness. Role of IT in supply chain management.

Mgt. 491 Agro – Industrial attachment 0+4 Sem. I
Agribusiness Industry in Public / Private Sector
(for agribusiness Management Practices / Processes)

Postgraduate Courses
Mgt. 501/ABM 501 Principles of Management and Organizational Behaviour 3+0 Sem. I
Concept of organization and organizational behaviour. Management-Definition, scope, importance and functions of management. Development of management thought- Taylor's scientific management, Fayol's principles of management, human relations approach etc. Planning and decision making, types of plans and planning process. Principles of planning. Management By Objectives (MBO). Organization structure - departmentation and its basis, span of management and factors influencing span of management, delegation of authority, line, staff and functional relationships. Role of behavioural sciences in organization. Individual behaviour, interpersonal and group behaviour. Motivation - concept, different theories of motivation, and motivational factors. Transactional analysis and group dynamics. Perception and defence mechanism, organisational conflict-its reasons and resolution. Controlling and directing human behaviour in organization, power, authority and influence. Communication-significance, process, barriers, and making communication effective. Leadership- definition, theories of leadership, leadership styles, managerial grid. Organisational development and change. Organisational effectiveness.

Mgt. 502/ABM 502 Business Environment 3+0 Sem. II
Business and its environment: nature, and importance, types of environment, environmental factors, environmental analysis and environmental scanning. Economic environment of business: nature and structure of economy. Planning in India- objectives of planning in India. Five-year plans- achievements and failures. Sectors of economy. Globalization and WTO- it's impact on economy. Government policies- industrial policy, monetary policy, fiscal policy, union budget. Social Environment: social responsibility of business and business ethics, corporate governance. Political environment of business. Legal environment: The Companies Act, 1956- nature of company, incorporation, commencement of business, types of companies, memorandum and articles of association, prospectus, management, and winding up of company. The consumer protection act. Introduction to the Indian Contracts Act-meaning of contract, nature, significance, and types of contracts. Technological environment-technology development and transfer.

Mgt. 503/ABM 503/Econ. 501 Managerial Economics/Micro Economics 3+0 Sem. I
Theory of consumer behavior- Cardinal Utility Approach, Ordinal Utility Approach. Applications of indifference curve approach. Revealed preference hypothesis. Demand theory, elasticity of

demand. Consumer surplus. Theory of the firm. Theory of production - production functions, returns to scale and economies of scale. Theory of costs - cost curves. Profit maximization and cost minimization. Law of supply, producers' surplus price determination under various market situations- monopoly, monopolistic competition, oligopoly. Theories of distribution. General equilibrium theory. Welfare economics.

Mgt. 504/ABM 504 Managerial Accounting and Control 2+1 Sem. I
Financial accounting: meaning, need, concepts and conventions. Branches of accounting, internal and external users of accounting. Advantages and limitations of financial accounting. Introduction to accounting standards. The double entry system: Its' meaning and scope. The journal, cash book, ledger, trial balance. Bank Reconciliation Statement: definition, importance and its' preparation. Trading account, profit and loss account, balance sheet, entries and adjustments of different heads in different books and accounts. Introduction to company final accounts. Management accounting: meaning, functions, scope, utility, limitations and tools of management accounting. Analysis of financial statements: ratios, comparative and common size statements, cash flow analysis. Cost accounting: nature, objectives, and significance. Elements and classification of costs. Marginal costing. Cost- volume-profit analysis: its' significance, uses and limitations. Standard Costing: Its' Meaning, Uses and Limitations, Determination of Standard Cost. Variance analysis: material, labour and overhead variances. Responsibility accounting: its' meaning and significance, cost, profit and investment centers. Budget and budgetary control: its' meaning, uses and limitations. Budgeting and profit planning. Different types of budgets and their preparations. Sales budget, purchase budget, production budget, cash budget, flexible budget, master budget, zero-based budgeting.
Practical: Numerical problems, case studies: analysis and discussion.

Mgt. 505/ ABM 505 Marketing Management 3+0 Sem. I
Introduction to marketing management, marketing concepts, managerial functions of marketing. Market and marketing environment, a review of existing Indian marketing environment, strategic marketing. Market segmentation- bases for segmenting consumer and business markets, targeting and positioning, marketing mix. Buyer behaviour -decision making process in marketing, marketing decision criteria and techniques. Marketing information system, marketing organization and control. Marketing potential and forecasting. Product strategy - product life cycle, new product development, product line and product mix, branding, packaging and labelling. Designing and managing services - managing service quality, managing service brands. Pricing strategy- factors affecting prices, pricing policies and strategies, pricing methods. Channel strategy- types of distribution channels, functions of channel members, channel conflicts, channel management decisions. Promotion strategy- promotion mix, introduction to advertising, personal selling, sales promotion, publicity, public relations and direct marketing. Managing integrated marketing promotion, Customer relationship management.

Mgt. 506/ABM 506 Human Resource Management 3+0 Sem. II
Introduction to human resources management- definition, scope, importance, functions and evolution of human resource management. Human resource planning- nature and significance, job analysis, job description, job specification, job enlargement, job enrichment, job rotation and job evaluation. Recruitment meaning, sources of recruitment and selection process, induction. Training and development- meaning, methods and making training and development effective. Internal mobility including transfers, promotions and employee separation. Performance appraisal - significance and methods, compensation management, wage and salary administration - meaning of wage, types of wages, wage theories, fringe benefits, incentive payment and bonus. Industrial relations- role and status of trade unions, Trade Unions Act, 1926. Workers' participation in management- meaning and forms. Employee welfare measures. Industrial disputes and dispute handling machinery. Grievance

handling procedures, arbitration and adjudication, law related to health, safety and welfare of human resources.

Mgt. 507/ABM 507 Financial Management 3+0 Sem. II

Introduction to financial management: meaning, functions, nature, objectives. Interface of financial management with other functional areas of a business. Financial statements and analysis: proforma balance sheet and income statements, ratio, time series, common size and Du-Pont analysis. Capital structure: determinants of size and composition of capital structure, capital structure theories, operating and financial leverage, cost of capital. Dividend policy: meaning of dividend, types of dividends, determinants of dividend policy. Sources of finance. Working capital management: determinants of size and composition of working capital, cash and receivables management, working capital management theories, financing of working capital, Tandon committee recommendations. Financial planning and forecasting. Capital budgeting: concepts and steps in capital budgeting, undiscounted and discounted cash flow methods of investment appraisal. Money and capital markets, functions of stock exchange. Securities and exchange board of India: organization and functions. Regional and all-India financial institutions. Venture capital financing and its stages. Introduction to micro finance. Introduction to international financial management.

Mgt. 508/ ABM 508 Production and Operations Management 3+0 Sem. II

Nature and scope of production and operations management- its relationship with other systems in the organization. Production functions, work and job design, facilities planning, product and process selection. Product design and development- importance of product design, characteristics of good design, technical process of new product development, design for manufacture, concurrent engineering. Facilities location- importance, location analysis techniques, facilities layout and materials handling. Capacity planning measuring capacity, process of capacity planning, methods for altering capacity in long term and short term. Production planning and control for different types of manufacturing systems, planning and control of projects, work study, method study, work measurement, work sampling, maintenance management, value engineering, quality assurance and quality circles. Total quality management, purchase system and purchase principles, inventory management, stores management, standardization, codification, quality control, certification systems and waste management.

Mgt. 509/ABM 509 Research Methodology in Business Management 2+1 Sem. II

Introduction to research methodology, research process, identification and formulation of problem. Research designs- exploratory research design, descriptive research design including cross-sectional design and longitudinal design. Secondary data, primary data, survey techniques and observation. Causal research design - experimentation, classification of experimental designs. Measurement and scaling techniques - nominal scale, ordinal scale, interval scale, ratio scale. Comparative scaling: paired comparison scaling, rank order scaling, constant sum scaling. Non-comparative scaling techniques - likert scale, semantic differential scale, stapel scale. Questionnaire design. Sampling design and procedures. Non-probability sampling techniques - convenience sampling, judgmental sampling, quota sampling and snowball sampling. Probability sampling techniques - simple random sampling, systematic sampling, stratified sampling and cluster sampling. Analysis of collected data- hypothesis testing, parametric and non-parametric statistics, factor analysis, cluster analysis and discriminant analysis. Report writing.

Practical: Case discussions, data collection, tabulation, analysis and report writing. Use of statistical packages for business solutions.

Mgt. 510/ABM 510 Strategic Management 3+0 Sem. II

Basic concepts of strategic management- phases and benefits of strategic management, impact of globalization on strategic management, theories of organizational adaptation, basic model of strategic management. Corporate governance and social responsibility. Environmental scanning and industry analysis, analysis of task environment, Porter's approach to industry analysis, hyper-competition. Internal scanning, organizational analysis. Strategy formulation - situation analysis and business strategy including Porter's competitive strategies, cooperative strategies. Corporate strategy- directional strategies including growth, stability and retrenchment strategies, portfolio analysis, corporate parenting. Functional strategy and strategic choice- core competencies, sourcing decisions, marketing, financial, operations and R&D strategy. Strategy implementation and control- developing organization structure, staffing and directing, use of non-financial measures for strategy implementation and control, balanced scorecard approach. Evaluation and control. Strategic issues in entrepreneurial ventures and small businesses. Strategic issues in not-for profit organizations. Case studies pertaining to environmental analysis, strategy formulation, implementation and control.

Mgt. 511/ ABM 511/IT 530 Management Information System 2+1 Sem. I

Concepts, needs and scope of MIS in business organization. Understanding business as a social system and information approach to management and organization theory. Types of management information systems. Business process reengineering. Design and implementation of MIS. Components of MIS, system flow charts, developing data base, integration of sub-systems, developing organization structure for MIS, MIS and control system. Enterprise Resource Planning (ERP): concepts, selection & implementation, and key success factors for ERP use. Aligning strategy & information systems. Uses of software packages and computer games for business decision making. Writing contracts for software development and purchase.

Practical: Use of software packages and simulations for business decision making, use of word processor for report writing and business correspondence, use of spreadsheets for problem solving and analysis of business situations, use of presentation graphics for making business presentations, use of internet and search engines.

Mgt. 512/ ABM 512/Econ. 508/Stat. 527 Quantitative and Optimization Techniques for Economics and Management 2+1 Sem. II

Role of quantitative methods in decision making, probability and decision making under risk and uncertainty, the value of additional information, Bayes theorem, probability models and decision making. Sample survey methods, measurement and forecasting, index numbers, time series analysis, optimization models, linear programming: formulation and simplex method, primal and dual, sensitivity analysis, transportation models and assignment models, dynamic programming, network analysis, PERT and CPM. Game theory: concept, two person constant sums, zero sum games, saddle point, solution to mixed strategies, Markov chain analysis, Queuing models- waiting line problem, characteristics of waiting lines, single channel model, multiple- channel model, constant-service time model, finite population model, sequencing and replacement models. Simulation and Monte Carlo methods.

Practical: Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex method. Formulation of simplex method by typical farm situations. Solution of other numerical problems, case studies, analysis and discussion.

Mgt. 513/ ABM 513 Project Management and Entrepreneurship Development 2+1 Sem. II

Concept and nature of projects, characteristics and types of projects, generation, identification and screening of project ideas, project life cycle. Formulation of projects: market and demand, technical and financial feasibility, preparation of feasibility report, methods for evaluation and

ranking of projects, risk analysis for projects, impact of inflation on projects, public and private projects, financing of projects, sources of finance and structure of financial institutions related to project financing, venture capital, central and state incentives, contract management for projects. implementation of project: network methods, project scheduling and resource allocation, project control and information system, monitoring and feedback, operational problems in implementation of projects. Concept and theories of entrepreneurship, significance of entrepreneurship in economic development, types of entrepreneurs, women and rural entrepreneurs, qualities of an entrepreneur, entrepreneurship development programmes and role of various institutions in developing entrepreneurship, lifecycle of new business, environmental factors affecting success of a new business, reasons for the failure and visible problems for business, developing effective business plans, procedural steps for setting up an industry.
Practical: Exercises in project formulation, numerical related to project evaluation, risk analysis and case studies.

Mgt. 514 Brand and Advertising Management 2+1 Sem. I
Understanding brands: product versus brand, concept of a brand, brand perspectives. Brand attributes: significance of branding to consumers & firms, selecting brand names, brand awareness, types of brand awareness, preference analysis. Brand image- type of associations, brand identity, brand personality, product and brand positioning. Creating core brand values, 3Cs and positioning strategy. Perceptual mapping. Multi-dimensional scaling system. Sustaining brand equity: sources of brand equity, dimensions of brand equity. Managing brands: building branding strategies. Brand extensions and line extensions. Brand evaluation and brand revitalization. Co-branding, umbrella branding, brand licensing and franchising, global branding. Introduction, nature and purpose of advertising, advertising strategy planning. Advertising goals and objectives. Message strategy: copy writing, copy testing strategy. Media strategy: media budget, media vehicle decisions.
Practical: Case studies, analysis and discussions.

Mgt. 515 International Marketing 3+0 Sem. II
International marketing: theories and concepts. Scanning the international environment. Regional economic groupings. Basis of international trade. Trends in world trade and composition of India's foreign trade, India's Foreign trade policy and its importance for developing economy. Balance of payment and instruments of trade policy. WTO and its agreements. Implications of WTO for Indian economy. International economic institutions. Institutional framework to promote Indian exports. Export assistance, IPR, state trading in India. Export documentation and procedures. Marketing strategies in world markets: modes of entry in foreign markets, market identification, product strategies, pricing policies, distribution system, promotion strategies. Overseas marketing research. Export finance. Risks faced by exporters. Problems of exporters

Mgt. 516 Sales Management and Consumer Behavior 2+1 Sem. I
Nature and scope of sales management, sales planning, sales organization, recruitment and selection of salesmen, training, compensating, controlling and evaluating the sales force, sales efforts. Marketing intelligence, sales forecasting, selling and public policy. Role of consumers in marketing, consumer decision making process, individual factors affecting purchase decisions, fundamental processes of sensation, perception, motivation, emotion, cognition and learning. Cultural and social factors. Consumer attitudes- formation and change. Group influence, family influence, life cycles effects in marketing. Diffusion of innovation. Researches in consumer behavior in India.
Practical : Case studies, analysis and discussions

Mgt. 517 Retail Management 3+0 Sem. I

Introduction to retailing- definition, concept and overview. Types of retail institutions. Targeting customers. Store location and site selection. Human resource management in retail organization. Retail operations management. Merchandise planning- inventory management and logistics. Inventory valuation. Forecasting and budgeting. Pricing strategy in retailing. Promotion strategy in retailing. Store design and layout- store and its image, store exterior, store interior, store layout, store display. Visual merchandise and atmospherics. Integrating and controlling the retail strategy. Managing retail services and services retailing. Out-of-store retailing. International retailing. Case studies, analysis and discussions.

Mgt. 518 Managing Rural Markets 2+1 Sem. II

Nature and magnitude of rural markets in India. Socio-cultural factors in rural marketing. Rural sales organization, special requirements for marketing in the rural areas with regard to product planning, communication channels, media and messages, marketing of agricultural inputs, distribution channels and systems, demand creation and market development, marketing of agri-inputs such as seeds, fertilizers, pesticides and farm machinery. Marketing of agricultural outputs. Determination of agricultural output and prices with special reference ACP Commission, systems of procurement- role of FCI and other procurement agencies, grading farm products, warehousing and cooperative marketing.
Practical: Case studies

Mgt. 519 Physical Logistics 2+1 Sem. II

Concept and significance of physicals logistic and distribution system; marketing and physical distribution process, elements of physical distribution system, transportation and its relation to plant location, warehousing and inventory; modes of transportation optimum relationship between size and frequency of shipments; transportation model; cost analysis and logistic system design; organization and management of physical distribution and logistic systems.
Practical: Exercise, case studies, analysis and discussions.

Mgt. 520 Management of Financial Institutions 2+1 Sem. I

Concept of capital market-role of specialized financial institutions and commercial banks. Consideration of bank functions, objectives, policies, organizations; management of primary and secondary reserves cash management and portfolio management; management of loans and advances, credit analysis and control. Tandon Committee and Chore Committee recommendations for Bank Financing. Management of funds and income, deposit and deposit mobilization, profitability analysis of commercial banks, management control and appraisal-transfer price mechanism, performance budgeting, evaluation of bank performance. Genesis of specialized financial institutions- IDBI, IFCI, ICICI, UTI, NABARD, LIC, SFCs and Sides -a brief overview of their objectives, functions and role, adequacy of capital and strategy of growth.
Practical: Case studies, analysis and discussions.

Mgt. 521 Management Control Systems 2+1 Sem. I

Functioning and structure- nature, functioning and objectives of control systems-strategic planning, management control and operational control, organizational relationships in management control, behavioral implications, motivation and goal congruence, management control structure- decentralization, responsibility centers-expense, profit and investment centers. Control process, budgeting and budgetary control, types of budgets and their preparation. Installation and evaluation of comprehensive budgeting control system. Standard costing and budgetary control. Analysis and reporting performance. Special management control situations-service organization, non-profit organizations and control of projects.
Practical: Case studies and Analysis.

Mgt. 522 Management of Financial Services 3+0 Sem. I

Indian financial system - introduction, structure. Non-banking finance companies- introduction, RBI Act framework. Asset liability management system. Leasing- concept, classification, significance and limitations. Financial Evaluation. Hire purchase finance and consumer credit-conceptual framework. Financial Evaluation. Factoring and forfeiting. Bill discounting-concepts, advantages. Housing finance- NHB, system. Refinance schemes, securitisation, mortgage-based securitisation, reverse mortgage scheme. Insurance- life and general products and concepts, IRDA Act. Mutual funds- concept and classification, advantages and mutual fund performance. Bonds- bond terminology, bond types, Indian bonds market. Issue management intermediaries, activities/procedures, pre-issue and post-issue obligations and requirements. Commodity markets and products. Stock broking, depositories, custodial services and securities lending scheme. Credit rating agencies, framework and rating process.

Mgt. 523 Investment Management 2+1 Sem. II

Investment objectives and constraints, types of investors. Investment analysis and stock exchanges in India. Market efficiency, modern portfolio theory, types of investment products. Security analysis- quantitative and qualitative variables, fundamental and technical analysis techniques, fixed income securities, portfolio management and performance measurement, derivative products - futures and options.

Practical: Numerical exercises and case studies, analysis and discussions.

Mgt. 524 International Financial Management 3+0 Sem. II

Financial management in a global context. The nature and measurement of exchange rate. Exposure and risk- approach, classification, treatment, interest rate exposure and risk. The international monetary system- exchange rate regimes, IMF and EMU. The foreign exchange market- structure, transaction types, quotations, arbitrage, pricing, foreign exchange market in India. Financing of foreign trade operations. Currency and interest rate futures- introduction, contracts, markets, trading, future prices, spot and forward prices, Hedging and speculation. Currency options - terminology, quotations, hedging, pricing models, embedded options and currency options in India. Exchange rate determination. Interest rate FRAs, Interest rate Caps and Floors. International bond market. International equity markets. International portfolio investments.

Mgt. 525 Tax Planning 2+1 Sem. II

Concepts and significance of tax planning, tax evasion and avoidance. Tax environment, implications and their impact on financial decision making and enterprise behavior. Fiscal policy and impact of central and state budgets, taxes under the jurisdiction of Union and state governments classification of taxes. Salient features and main legal provisions of income tax and other acts relating to incentives and concessions. Tax planning for individuals and corporate sector.

Practical: Numerical exercises and case studies.

Mgt. 526 Production Planning and Control 2+1 Sem. I

Nature and objectives of production planning and control, variables subject to control. Production control for continuous, intermittent and project systems. Learning curve effects, production forecasting and production inventories. Aggregate planning guidelines, graphic and charting methods, mathematical planning models. Scheduling philosophy, scheduling methodology and control techniques. Development of means to reporting production and comparison of schedule with actual performance development of standards.

Practical: Exercises in the use of quantitative techniques and analysis and discussion of case studies.

Mgt. 527/ Econ. 503/ Stat. 511 Econometrics 2+1 Sem. I

Introduction - relationship between economic theory, mathematical economics, models and

econometrics. Methodology of econometrics. Representation of economic phenomenon, relationship among economic variables, linear and non-linear economic models. Analysis of economic time series components and their interpretation. Ordinary least squares methods of estimation of simple and multiple regression models. The BLUE properties of least squares estimate, tests of significance and confidence intervals. Indirect least square method of estimation. Maximum likelihood estimation. Problems of multicollinearity, heteroscedasticity and auto-correlation. Principal component analysis, use of dummy variables. Generalized Aitkin's least squares methods of estimation. Distributed lag models. Estimation from grouped data. Application of computer software for solving practical econometric problems. Simultaneous equation models structural equations, reduced form equations, identification and approaches to estimation.
Practical: Practicals on single equation two variable model specification and estimation, hypothesis testing, transformations of functional forms and OLS application. Estimation of multiple regression models - hypothesis testing, testing and correcting specification errors, testing and managing multicollinearity, heteroscedasticity, autocorrelation. Estimation of regressions with dummy variables, estimation of regression with limited dependent variable. Identification of equations in simultaneous equation systems.

Mgt. 528 Cost Control and Value Analysis **2+1** **Sem. I**
Cost control concepts-components, types and control. Budgets-fixed and flexible, cost standards, labour costs, material costs and overhead costs. Analysis of cost variance labour variance, material variance and overhead variance. Cost reporting and correction. Principles and techniques of cost reduction. Basic concepts and value engineering, historical perspectives, functions and value. Job plans, fast diagrams and other value engineering tools. Behavioral and organizational aspects of value engineering, benefits of value engineering.
Practical: Case studies in value engineering.

Mgt. 529 Work Study **2+1** **Sem. II**
Work measurement, work simplification or reduction of human effort through simplifying, combing, eliminating or changing processes. Study of process charts, study of symbols. Meaning of effecting work simplification through time and motion study. Development of standard method's and standard times for all operations.
Practical: Exercises, case studies, analysis and discussions.

Mgt. 530 Operations Management **3+0** **Sem. II**
Planning and organization of operations, operations management concepts, material and equipment inputs, human resource inputs and capital inputs. Use of advanced computer techniques. Directions and control of operations, product and process analysis, forecasting various control techniques including inventory, quality, maintenance and cost control. Operating environment.

Mgt. 531 Purchasing and Materials Management **3+0** **Sem. II**
Fundamentals of purchasing and materials management, determinants of right materials, quality specifications and standardization, reliability and inspection, price, service and delivery, sources of supply, make or buy decisions, inventory control systems, value analysis/engineering, traffic, stores and record keeping, management of procurement and materials activities, institutional and government purchasing.

Mgt. 532 Personnel Management Practices **2+1** **Sem. I**
Role of personnel manager in organisation, status and background and personnel managers, personnel policies framework, formulation and execution of policies relating to major personnel functions, current development and role of social and demographic factors in personnel functions. Industrialization - its growth implications and problems. Role of industrial

psychology in job analysis and personnel testing. Performance appraisal, training and development, job and work situation and job satisfaction. Current developments and personnel practices on effective functioning of an organisation.
Practical: Case studies, analysis and discussions.

Mgt. 533 Human Resource Development 3+0 Sem. I
Concept, significance and mechanisms of HRD. Line managers and HRD, Developmental supervision, Management development and HRD. Motivational aspects of HRD. Career planning and development, performance management and internal mobility. Executive training- satisfaction of training needs of executives, supervisions and managers, training programmes, methods and techniques evaluations of training programme and progress, training budget. Management training and development in India. Organizational culture and Quality of Work Life. Organization development (OD) and HRD-components, process and technology of OD, team building.

Mgt. 534 Industrial Relations in India 2+1 Sem. I
Industrial relations, role of government in IR and industrial conflicts, code of discipline, standing orders, grievance handling, mediation, conciliation, adjudication, arbitration, trade unions and industrial relations, collective bargaining, industrial democracy. Labour welfare-concept, nature and types of welfare plans, welfare administration. Welfare legislation -social security administration. Industrial relations in western countries. Industrial relations in public and private sectors in India. Problems of industrial relations at major industrial towns.
Practical: Case studies, analysis and discussions.

Mgt. 535 Business Ethics and Indian Management 3+0 Sem. II
Societal concept and social responsibility of business: spectrum of social issues-conservation of natural resources, pollution control and other environmental issues. Fair business practices, human resources, consumer and community involvement. Business ethics and unethical behaviour of managers. Ethical code and legal requirements in different areas. Ethical pressure points, pressure from superiors, comparative conceptual disparity and ambiguous situations. Ethical climate of organisation, policies and guidelines of ethics, educational influence, code of conduct, ethical advisor, value systems of Indian managers.

Mgt. 536 Industrial and Labour Laws 2+1 Sem. II
Concept of labour welfare and role of industrial and labour legislation, safety and welfare legislation, Factories Act, Workmen's Compensation Act, Minimum Wages Act, Employees State Insurance Act, Employees Provident Fund Act, Employees Family Pension Scheme, Maternity Benefit Act, Payment of Bonus Act, Trade Union Act. Administration and labour laws.
Practical: Case studies, analysis and discussion.

Mgt. 537 Farm Business Management 3+0 Sem. I
Nature, scope and functions of farm business management, working out existing and alternative farm plans, farm labour, farm capital and its problems, farm machinery and its utilization, decision making process in farm management, application of quantitative techniques in agricultural production, marketing of agricultural output, purchasing the agricultural inputs, management of other special farm projects like poultry, dairy, fishery, bee-keeping and piggery, farm forecasting and other special managerial problems of farms.

Mgt. 538 Management of Cooperatives 3+0 Sem. I
Nature of cooperative principles, management principles and their applications to cooperative organizations, structure and functions of various types of cooperatives, managerial problems of cooperatives, consumer stores, role of government, financing of cooperatives, staffing and

training, efficiency criteria, public accountability, price, output and profit policies of cooperatives. Special problems of cooperatives in agricultural and industrial sectors, management practices of successful cooperatives in India.

Mgt. 539 Agricultural Marketing **3+0** **Sem. I**
Advanced study of organization and function of agricultural marketing in India. Market structure and performance, determination of price and marketing margins, technological evolution and integration in agricultural processing, distribution; warehousing and cooperative marketing; methods of grading of farm product-market grades, unique features of commodity marketing in India. Market legislation- a historical and critical review; magnitude and dimensions of marketed and marketable surplus of agricultural commodities; efficiency of marketing, storage, transportation and financial management in agricultural marketing, perishability, seasonability and processing of different agricultural products, pricing of processed products and demand creation.

Mgt. 540 Rural Finance **3+0** **Sem. II**
Functions, structure and working of rural financial market in India, role of rural financing institutions like NABARD, RRBs, credit policies of various financing institutions, agricultural credit policy since independence, mobilizing rural savings, rural deposits mobilization by cooperatives, innovative financing, intensive financing, village adoption.

Mgt. 541 Management of Strategic Organizations **3+0** **Sem. II**
Concept and significance of strategic organizations, public sector enterprises, Sunrise industries, research and training institutions, development oriented voluntary organizations, extension and promotional agencies, form, objectives, special features, internal structure, staffing and training, efficiency criteria, public accountability, motivation, control and leadership in strategic organizations with special reference to public sector enterprises and developmental agencies.

Mgt. 542 Management of Agro-Industrial Projects **2+1** **Sem. II**
Nature of agro-industrial projects. Formulation of agro-industrial projects - economic, technical and financial feasibility, generation of alternative project ideas and preliminary screening; methods for evaluation and ranking of projects, preparation of feasibility report, financing of agro-industrial projects, sources of finance and structure of financial institutions, central and state incentives, implementation of project, organization viability, management control and information system, monitoring and feedback, operational problems in implementation of projects.
Practical: Exercises in project formulation and case studies.

Mgt. 543 Management of Research and Development **2+1** **Sem. II**
Role of research and development activities within business enterprises. Effective management of research and development functions - determining research and development needs of organization, establishing priorities, developing R & D plans and strategies, preparing budgets, characteristics of effective R & D programmes. Personnel, financial and accounting control, schedule control, project evaluation and corrective action.
Practical: Case studies, analysis and discussion

Mgt. 544 Managing E-Business **3+0** **Sem. I**
Creation of Idea. Developing of Business Plan. Revenue Model. Funding by Venture Capitalist. Digital Marketing: Brand creation, customization. Product Development, pricing transparency and dynamics, B2B channels. B2C channels. Promotion for traffic building. Understanding virtual value chain and space management. Running of e-business. Security Issues. Pitfall/ Problems in managing e-business. IT enabled services.

Mgt. 545 E-Commerce Technologies 2+1 Sem. I

Introduction to Internet and intranet, www (Network essentials, HTML. Introduction to Protocols and services). Concepts: working, surfing and security on the internet. Web : worldwide web, advantages of web, web terminology, web access using browsers and search engines. Introduction to various E- commerce technologies, E-Commerce transactions. Strategies, issues and remedies. Study of different types of browsers. Sending and receiving E-Mails. Assessing files with FTP. Viewing and using graphic files. Working with newsgroups, real time chat on internet and intra-net. Selecting an internet service provider. Transfer of information on internet and intranet. Private virtual networks. Net phones. Client server architecture, work load distribution. Application of E-Commerce technologies for business decisions.

Practical: Practicals related to Internet and Intranet browsing, downloading and development of internet and intranet based business solutions. Case studies related to E-business and technologies used therein.

Mgt. 546 Data Management for Decision Makers 2+1 Sem. II

Introduction to data and its concepts. Basic concepts. Entities and their attributes, relationship, records and files. Abstraction and data integration. Proposal for DBMS, data independence, components of DBMS, advantages and disadvantages of DBMS. Data models: Relational, Hierarchical and Distributed. Relational Data Model: Relational databases - attributes and domains, relation and their schemes. Relations representation, key relationship, relation operations, integrity rules. Data reliability and authenticity. Entity relationship, data processing and report generation. Data definition, view and queries: types (individual and form based). Data protection: recovery, concurrency, security, integrity and control of information, data encryption. Debugging and performance evaluation of software, software documentation. Development of online help. Introduction to ERP.

Practical: Applications in RDBMS for business solutions.

Mgt. 547 Current Issues in E-Business 3+0 Sem. II

Latest developments in the area of e-business/e-commerce and e-governance including technical, legal and behavioural issues. Impact of these issues in the overall business environment and emergence of various opportunities and threats. Development of Strategies.

Mgt. 595 In-Industry Training 0+5 (NC)

Each student is required to undergo "In-Industry Training" in a business organization for six weeks. The purpose is to expose the students to the practical aspects of management. At the end of the training programme, the student is required to submit a report. This report and the overall performance of the student in the organization form the basis of evaluation of student's work.

Mgt. 601 Management Thought 2+0 Sem. I

Early contributions to development of management thought- Catholic Church, military organization, intellectuals from 16th to 18th century. Contributions of important thinkers such as James Watt, Boulton, Robert Owen, Charles Babbage, Henry Poor, Henry Towne, Frederick Taylor, Henry Fayol, Gilbreth, Mary Parker Follett, Elton Mayo, C. I. Barnard, A. P. Sloan, Max Weber and others. Human Relations Approach, Behavioural Science Theorists, Quantitative Approach, Systems Approach, Contingency Approach and Process Approach to management.

Mgt. 602 Comparative Management 2+0 Sem. II

Need, importance and scope of comparative management. Impact of national and cultural differences on management. Management in different economic systems-Chinese, Japanese,

American and Indian. Lessons from the collapse of socialistic system in Russia, Globalization and management convergence - globalization and internationalism and rationalization, Managing and developing cross cultural organizations, Hofstede's cultural theory. Management in public sector and third sector organisations - management of hospitals, educational institutions and tourism. Management in agriculture. Forest Management.

Mgt. 603 Advanced Financial Management 3+0 Sem. I
An integrated view of financial decisions, investment decisions and dividend decisions of firm. Dividend policy. Maximizing owners' wealth and its impact on market price. Retention and dividend decisions. A critical evaluation of dividend policies of Indian firms. Financial structure of firm. Financing Decisions and valuation of firm, internal financing decisions and growth of firm. Appraisal of valuation formula, optimum financing decisions under conditions of certainty, risk and uncertainty. Financial rearrangement and reorganization for mergers and amalgamations.

Mgt. 604 Management Information and Control Systems 3+0 Sem. II
Management information systems - perspectives, management information needs, purpose, scope, design of management information systems, major and minor management information systems, need for control, need for management training, implementing management information systems, problems and pitfalls, simulation and information retrieval, management information systems and automation, managerial interference, technology and foundation of management information systems. Management Control Systems - profit planning and control, sales, production and expenses, performance reports for management control.

Mgt. 605 Advanced Accounting Theory and practice 3+0 Sem. II
Accounting theory and accounting profession, methodology of accounting theory, development of accounting theory, accounting objectives, concepts, measurements and structure of accounting theory, international accounting standards, concepts of income reporting. Theoretical evaluation of revenues and expenses, gains and losses, business income and price changes. Valuation of assets, depreciation and human resource accounting. Company accounts, allotment, transfer and forfeiture of shares. Appropriation of profit, acquisition, amalgamation and absorption of business, reconstruction. Holding company accounting and branch accounting. Interpretation of financial accounts.

Mgt. 606 International Financial Management 2+0 Sem. I
Financial problems of multinational corporations in different environment. Evaluation of direct investment opportunities and financial planning and control of multinational corporations. Criteria for selection of investments, outlets in foreign countries. Multinational capital budgeting, working capital management, sources and instruments of international finance planning; subsidiaries, financial structure. Consolidation of financial reports of subsidiaries and parent corporations. Financial problems of joint ventures. Management of international fund movements.

Mgt. 607 Financial Reporting 2+0 Sem. I
Financial reports - general and special purpose. Regulations regarding disclosures of public sector enterprises, nature of disclosures, standards for disclosures, accounting problems of disclosure. Financial management - reports of board of Directors, Chairman's speech, supplementary statements, schedules, footnotes etc. Disclosure of non-financial information. Disclosure of multi-unit and diversified firms, financial disclosures of Indian companies.

Mgt. 608 Statutory Cost and Management Audit 2+0 Sem. II
Auditing philosophy, audit objectives and techniques, principles of auditing, methodology of audit, audit programme design, audit of cash and trading transactions, audit of impersonal and

personal ledgers, balance sheet audit, verification and investigation of assets. Rights, duties and responsibilities of an auditor. Independence in audit, concentration of audit, statistical sampling techniques and auditing. Cost audit-principles and procedure, audit and internal control, audit reporting problems. Management audit - problems in developing performance standards, management audit procedures and reporting on management audit.

Mgt. 609 Portfolio Management **2+0** **Sem. I**
Concepts of portfolio management, strategy of risks and returns, different approaches to portfolio management, personal portfolio management, portfolio management of investment companies, trusts, commercial banks, development institutions, insurance companies and pension funds. Role of computer in portfolio management.

Mgt. 610 Advanced Marketing Management **3+0** **Sem. II**
Development of marketing thought, marketing environment in India - Historical analysis, innovative marketing, marketing information, marketing productivity, cost and profitability. Productivity analysis of goods and services, customers and territories, advertising, distribution and field sales operations. Model building for analysis and interpretation of marketing data, deterministic optimizing models, stochastic process models, experimental designs, discriminant and canonical analysis, factors and cluster analysis, heuristic models, behaviour models.

Mgt. 611 Marketing Strategy **3+0** **Sem. I**
Marketing strategy, marketing mix strategies for consumer, consumer durables and non-durable goods, marketing strategies during stagflation and shortages, principles of marketing planning, planning systems, resources and objectives, corporate marketing strategies, forecasting, designing marketing, campaign facilities. Implementation of marketing strategies - organization system, testing a plan, performance analysis, efficiency control and marketing audit.

Mgt. 612 Retail and Wholesale Management **3+0** **Sem. II**
Locating, planning and organizing store, merchandise planning and buying. Pricing stock holding, stock control, control of expenses. Brief introduction to marketing channels, operation of retail and wholesale enterprises. Concept of retailing and wholesale, functions of retailer and wholesaler. Retailer's and wholesaler's environment. Theory of retailer- supplier conflict, control and co-operation. Salesmanship and sales promotion, pattern of evolution in retailing and wholesale institutions. Innovation and change.

Mgt. 613 Marketing Legislation in India **2+0** **Sem. I**
Various central and states statutes and legislation. Evolution of various governmental regulations. Selected statutes such as MRTP Act, Essential Commodities Act, Quality, Price and Distribution Control Legislation, Pure Food Legislation, Trade Mark, Copyright and Patent Legislation.

Mgt. 614 Financial Strategies for Marketing Operations **2+0** **Sem. II**
Analytical and creative approach to financial dimensions of marketing decisions. Setting financial objectives of marketing functions in an organization, marketing investment and management. Financial analysis of decisions involving product service expansion, contraction and substitution, product service development, credit sales analysis, analysis for pricing decisions, financial aspects of promotion, sales force management and other marketing operations.

Mgt. 615 Systems Analysis **2+0** **Sem. I**
An overview of systems types, purposive systems, man made systems, cybernetics and

systems models, control and analysis of hierarchical systems, adaptive systems and learning models, control theory of social and economic systems, mathematical models, decision frame work for systems evaluation, criteria for evaluating public planning programme and budgeting systems.

Mgt. 616 Project Management with PERT and CPM 2+0 Sem. I
Developing project network, time estimates and their distributions, basic scheduling computations, variations of basic scheduling computations, scheduling activities to satisfy resource constraints, time- cost trade-off procedures. An introduction to network cost control. PERT-statistical approach, critical path methods.

Mgt. 617 Inventory Management 2+0 Sem. II
Various types of inventory systems, maintaining smooth supply of raw-materials and finished products for production and marketing. Structure of optimal inventory policies, deterministic and stochastic models. Planning horizon theorem, parametric production planning, stochastic ordering, single critical level policies, myopia policies, Bayesian models, dependence of optimum policies in various parameters.

Mgt. 695 Advanced In-Industry training 0+7 (NC)
To provide in-depth knowledge of the field problems and actual operation of business organization, the student will be sent for in-industry training for 6-8 weeks and will be required to submit training report and collect cases. This will form the basis of evaluation.

Mgt. 591 Seminar

Mgt. 600 Project Research

Mgt. 700 Ph.D. Research

ABM 501/ Mgt. 501 Principles of Management and Organizational Behaviour 3+0 Sem. I
Concept of organization and organizational behaviour. Management-definition, scope, importance and functions of management. Development of management thought- Taylor's scientific management, Fayol's principles of management, Human Relations Approach etc. Planning and decision making, types of plans and planning process. Principles of planning, Management By Objectives (MBO). Organization structure - departmentation and its basis, span of management and factors influencing span of management, delegation of authority, line, staff and functional relationships. Role of behavioural sciences in organization. Individual behaviour, interpersonal and group behaviour. Motivation - concept, different theories of motivation, and motivational factors. Transactional analysis and group dynamics. Perception and defence mechanism, organisational conflict-its reasons and resolution. Controlling and directing human behaviour in organization, power, authority and influence. Communication-significance, process, barriers, and making communication effective. Leadership- definition, theories of leadership, leadership styles, managerial grid. Organisational development and change. Organisational effectiveness.

ABM 502/Mgt. 502 Business Environment 3+0 Sem. II
Business and its environment: nature, and importance, types of environment, environmental factors, environmental analysis and environmental scanning. Economic environment of business: Nature and structure of economy. Planning in India- objectives of planning in India, five-year plans- achievements and failures. Sectors of economy. Globalization and WTO- It's impact on economy. Government policies- Industrial Policy, Monetary Policy, Fiscal Policy, Union Budget. Social Environment: social responsibility of business and business ethics,

corporate governance. Political environment of business. Legal environment: The Companies Act, 1956- nature of company, incorporation, commencement of business, types of companies, memorandum and articles of association, prospectus, management, and winding up of company. The Consumer Protection Act, introduction to the Indian Contracts Act- meaning of contract, nature, significance, and types of contracts. Technological environment- technology development and transfer.

ABM 503/Mgt. 503/ Econ. 501 Managerial Economics /Micro Economics **3+0** **Sem. I**

Theory of consumer behavior- Cardinal Utility Approach, Ordinal Utility Approach, Applications of Indifference curve approach, Revealed Preference Hypothesis. Demand theory, elasticity of demand. Consumer surplus. Theory of the firm. Theory of Production - production functions, returns to scale and economies of scale. Theory of Costs - cost curves, profit maximization and cost minimization. Law of Supply, producers' surplus price determination under various market situations- monopoly, monopolistic competition, oligopoly. Theories of distribution. General Equilibrium Theory. Welfare economics.

ABM 504/Mgt. 504 Managerial Accounting and Control **2+1** **Sem. I**

Financial accounting: meaning, need, concepts and conventions. Branches of accounting, internal and external users of accounting. Advantages and limitations of financial accounting. Introduction to accounting standards. The double entry system: Its' meaning and scope. The journal, cash book, ledger, trial balance. Bank Reconciliation Statement: definition, importance and its' preparation. Trading account, profit and loss account, balance sheet, entries and adjustments of different heads in different books and accounts. Introduction to company final accounts. Management accounting: meaning, functions, scope, utility, limitations and tools of management accounting. Analysis of financial statements: ratios, comparative and common size statements, cash flow analysis. Cost accounting: nature, objectives, and significance. Elements and classification of costs. Marginal costing. Cost- volume-profit analysis: its' significance, uses and limitations. Standard Costing: Its' Meaning, Uses and Limitations, Determination of Standard Cost. Variance analysis: material, labour and overhead variances. Responsibility accounting: its' meaning and significance, cost, profit and investment centers. Budget and budgetary control: its' meaning, uses and limitations. Budgeting and profit planning. Different types of budgets and their preparations. Sales budget, purchase budget, production budget, cash budget, flexible budget, master budget, zero-based budgeting.
Practical: Numerical problems, case studies: analysis and discussion.

ABM 505/ Mgt. 505 Marketing Management **3+0** **Sem. I**

Introduction to marketing management, marketing concepts, managerial functions of marketing. Market and marketing environment, a review of existing Indian marketing environment, strategic marketing. Market segmentation- bases for segmenting consumer and business markets, targeting and positioning, marketing mix. Buyer behaviour -decision making process in marketing, marketing decision criteria and techniques. Marketing information system, marketing organization and control. Marketing potential and forecasting. Product strategy - product life cycle, new product development, product line and product mix, branding, packaging and labelling. Designing and managing services - Managing service quality, managing service brands. Pricing strategy- factors affecting prices, pricing policies and strategies, pricing methods. Channel strategy- types of distribution channels, functions of channel members, channel conflicts, channel management decisions. Promotion strategy- promotion mix, introduction to advertising, personal selling, sales promotion, publicity, public relations and direct marketing. Managing integrated marketing promotion, Customer relationship management.

ABM 506/Mgt. 506 Human Resource Management **3+0** **Sem. II**

Introduction to human resources management- definition, scope, importance, functions and evolution of human resource management. Human resource planning- nature and significance, job analysis, job description, job specification, job enlargement, job enrichment, job rotation and job evaluation. Recruitment meaning, sources of recruitment and selection process, induction. Training and development- meaning, methods and making training and development effective. Internal mobility including transfers, promotions and employee separation. Performance appraisal - significance and methods, compensation management, wage and salary administration - meaning of wage, types of wages, wage theories, fringe benefits, incentive payment and bonus. Industrial relations- role and status of trade unions, Trade Unions Act, 1926, Workers' participation in management- meaning and forms. Employee welfare measures. Industrial disputes and dispute handling machinery. Grievance handling procedures, arbitration and adjudication, Law related to health, safety and welfare of human resources.

ABM 507/Mgt. 507 Financial Management 3+0 Sem. II

Introduction to financial management: meaning, functions, nature, objectives. Interface of financial management with other functional areas of a business. Financial statements and analysis: proforma balance sheet and income statements, ratio, time series, common size and Du-Pont analysis. Capital structure: determinants of size and composition of capital structure, capital structure theories, operating and financial leverage, cost of capital. Dividend policy: meaning of dividend, types of dividends, determinants of dividend policy. Sources of finance. Working capital management: determinants of size and composition of working capital, cash and receivables management, working capital management theories, financing of working capital, Tandon committee recommendations. Financial planning and forecasting. Capital budgeting: concepts and steps in capital budgeting, undiscounted and discounted cash flow methods of investment appraisal. Money and capital markets, functions of stock exchange. Securities and exchange board of India: organization and functions. Regional and all-India financial institutions. Venture capital financing and its stages. Introduction to micro finance. Introduction to international financial management.

ABM 508/Mgt. 508 Production and Operations Management 3+0 Sem. II

Nature and scope of production and operations Management- its relationship with other systems in the organization. Production functions, work and job design, facilities planning, product and process selection. Product design and development- importance of product design, characteristics of good design, technical process of new product development, design for manufacture, concurrent engineering. Facilities location- importance, location analysis techniques, facilities layout and materials handling of various agricultural products. Capacity planning- measuring capacity, process of capacity planning, methods for altering capacity in long term and short term. Production planning and control for different types of manufacturing systems related to agri-business, planning and control of projects, work study, method study, work measurement, work sampling, maintenance management, value engineering, quality assurance and quality circles. Total quality management, commodity purchase system and purchase principles, inventory management, stores management, food grading, packaging, standardization, codification, quality control, certification systems and agri-waste management.

ABM 509/ Mgt. 509 Research Methodology in Business Management 2+1 Sem. II

Introduction to research methodology, research process, identification and formulation of problem, Research designs- exploratory research design, descriptive research design including cross-sectional design and longitudinal design. Secondary data, primary data, survey techniques and observation. Causal research design - experimentation, classification of experimental designs. Measurement and scaling techniques nominal scale, ordinal scale,

interval scale, ratio scale. Comparative scaling: paired comparison scaling, rank order scaling, constant sum scaling. Non-comparative scaling techniques - likert scale, semantic differential scale, stapel scale. Questionnaire design. Sampling design and procedures. Non-probability sampling techniques - convenience sampling, judgmental sampling, quota sampling and snowball sampling. Probability sampling techniques - simple random sampling, systematic sampling, stratified sampling and cluster sampling. Analysis of collected data- hypothesis testing, parametric and non-parametric statistics, factor analysis, cluster analysis and discriminant analysis. Report writing.
Practical: Case discussions, data collection, tabulation, analysis and report writing. Use of statistical packages for agribusiness solutions.

ABM 510/ Mgt. 510 Strategic Management 3+0 Sem. II
Basic concepts of strategic management- Phases and benefits of strategic management, impact of globalization on strategic management, theories of organizational adaptation, basic model of strategic management. Corporate governance and social responsibility. Environmental scanning and industry analysis-analysis of task environment, Porter's approach to industry analysis, hyper-competition. Internal scanning-organizational analysis. Strategy formulation - situation analysis and business strategy including Porter's Competitive strategies, cooperative strategies. Corporate strategy- directional strategies including growth, stability and retrenchment strategies, portfolio analysis, corporate parenting. Functional strategy and strategic choice- core competencies, sourcing decisions, marketing, financial, operations and R&D strategy. Strategy implementation and control- developing organization structure, staffing and directing, use of non-financial measures for strategy implementation and control, balanced scorecard approach. Evaluation and control, Strategic issues in entrepreneurial ventures and small businesses. Strategic issues in not-for- profit organizations. Case studies pertaining to environmental analysis, strategy formulation, implementation and control.

ABM 511/ Mgt. 511 Management Information System 2+1 Sem. I
Concepts, needs and scope of Management Information System (MIS) in business organization. Understanding business as a social system and information approach to management and organization theory. Types of management information systems- transaction processing systems, office automation systems, decision support systems, executive support systems, knowledge based expert systems. Business process reengineering, design and implementation of MIS. Components of MIS, system flow charts, developing data base, integration of sub-systems, developing organization structure for MIS, MIS and control system. Enterprise Resource Planning (ERP)- concepts, selection & implementation, and key success factors for ERP use, aligning strategy & information systems. Use of internet in agribusiness. GIS and remote sensing.
Practical: Use of software packages and simulations for agribusiness decision making, use of word processor for report writing and business correspondence, use of spreadsheets for problem solving and analysis of business situations, use of presentation graphics for making business presentations, use of internet and search engines.

ABM 512/Econ. 508/ Mgt. 512/Stat. 527 Quantitative and Optimization Techniques for Economics and Management 2+1 Sem. II
Role of quantitative methods in decision making, probability and decision making under risk and uncertainty, the value of additional information, Bayes theorem, probability models and decision making. Sample survey methods, measurement and forecasting, index numbers, time series analysis, optimization models, linear programming: formulation and simplex method, primal and dual, sensitivity analysis, transportation models and assignment models, dynamic programming, network analysis, PERT and CPM. Game Theory: concept, Two person constant sums, zero sum games, saddle point, solution to mixed strategies, Markov

chain analysis, Queuing models- waiting line problem, characteristics of waiting lines, single channel model, multiple- channel model, constant-service time model, finite population model, sequencing and replacement models. Simulation and Monte Carlo methods.
Practical: Graphical and algebraic formulation of linear programming models, Solving of maximization and minimization problems by simplex method. Formulation of simplex method by typical farm situations, Solution of other numerical problems, case studies, analysis and discussion.

ABM 513/ Mgt. 513 Project Management and Entrepreneurship Development **2+1** **Sem. II**

Concept and nature of agro-industrial projects, characteristics and types of projects. Generation, identification and screening of project ideas, project life cycle. Formulation of agro industrial projects - market and demand, technical and financial feasibility, methods for evaluation and ranking of projects, risk analysis for agro-industrial projects, impact of inflation on projects, preparation of feasibility report. Financing of agro-industrial projects, sources of finance and structure of financial institutions related to agribusiness, venture capital. Central and state incentives for agribusiness. Implementation of project: network methods, project scheduling and resource allocation, project control and information system, monitoring and feedback, operational problems in implementation of agribusiness projects. Entrepreneurship, Significance of entrepreneurship in economic development, qualities of an entrepreneur, entrepreneurship development programmes and role of various institutions in developing entrepreneurship, lifecycle of new business, environmental factors affecting success of a new business, reasons for the failure and visible problems for business, developing effective business plans, procedural steps for setting up an industry.
Practical: Exercises in project formulation, numerical problems related to project evaluation, risk analysis and case studies.

ABM 514 Rural Marketing Management **2+0** **Sem. I**

Rural marketing- concept and importance, characteristics and structure of rural markets, problems in rural marketing. Environmental factors affecting rural marketing- socio-cultural, economic, demographic, technological and other factors. Rural consumer behaviour, customer relationship management, rural market research. Rural marketing strategies- segmenting, targeting, positioning of rural markets, product planning, product mix, pricing policy and pricing strategy. Distribution and promotion strategies for rural markets- Rural communication and problems. Marketing of agricultural inputs, consumer durables and farm produce. Packaging, transportation, grading and standardization, storage and processing of agricultural produce, financing for rural marketing, marketing agencies and institutions for rural markets, innovation in rural marketing.

ABM 515 Management of Food Processing Industry **2+0** **Sem. II**

Overview of food processing industry scenario in India, world trade in processed foods-prospects and challenges. Present status of food industry, deteriorative factors and hazards during processing, storage, handling and distribution. Management of functional areas of food processing units- capacity planning , sourcing of raw material, scope of contract farming, problems faced by food processing units, packaging of foods. Analysis of costs in food organization, risk management. Laws and regulations related to food industry and food production and marketing. Quality management- quality standards, PFA and ISO. Case studies on project formulation in various types of food industries- milk and dairy products, cereal milling, oil-seed and pulse milling, sugarcane milling, honey production, baking, confectionary, oil and fat processing, fruits and vegetable storage and handling, processing of fruits and vegetables, egg, poultry, fish and meat handling and processing.

ABM 516 International Trade and Marketing for Agribusiness **3+0** **Sem. I**

Introduction, scanning the international environment for agribusiness, composition of international trade-comparative and competitive advantage, recent trends in world trade and India's foreign trade in the area of agribusiness. India's foreign trade policy and its importance for developing economy, instruments of trade policy - quotas, antidumping duties, quantitative and qualitative restrictions, tariff, non-tariff measures and trade control, India's balance of payments, exchange rate. WTO and its agreements, implications of WTO for Indian economy and agriculture sector in particular, TRIPS, TRIMS, subsidies- green and red boxes, countervailing duty measures, carbon trade, SPS agreement. Regional economic groupings, export promotion institutions with special emphasis on EPCs and commodity boards, MPEDA, APEDA and service institutes. Import- export documentation, role of ECGC in insurance, identifying foreign markets for agri products, international marketing - market entry methods, international product planning, pricing, promotion, distribution, problems of exporters, legal dimensions of international marketing. Exercises in international agribusiness management, case studies.

ABM 517 Supply Chain Management 3+0 Sem. I

Supply chain- changing business environment. Supply Chain Management (SCM)- present need, conceptual model of SCM, evolution of SCM. Concept and significance of physical logistic and distribution system as applicable in agribusiness, marketing and physical distribution process, elements of physical distribution system, transportation and its relation to plant location, warehousing and inventory, modes of transportation, optimum relationship between size and frequency of shipments, transportation model. Vendor Managed Inventory (VMI), third -party logistics, GPS technology. Supply chain management in agri-business, procurement management in agri supply Chain - purchasing cycle, types of purchases, contract/corporate farming, Various models of supply chain management as followed by developed countries. Cost analysis and logistic system design, organisation and management of physical distribution and supply chain. Concept of Information Technology (IT) - IT Applications in SCM, SCM in electronic business, role of knowledge in SCM. Performance measurement and controls in agri supply chain management.

ABM 518 Marketing of Agricultural Inputs 2+0 Sem. I

Agricultural input marketing: meaning and importance, management of distribution channels, agricultural inputs and their types, role of cooperative, public and private sectors in agri input marketing. Seed- importance, types of seeds- hybrid, high yielding and quality seeds. Demand and supply, marketing channels, pricing, export and import. Role of NSC and State Seed Corporation. Chemical fertilizers - production, exportimport, supply, demand and consumption, pricing policy, subsidy, marketing system, problems in distribution. Role of IFFCO and KRIBCO. Plant protection chemicals- production, export/import, consumption, marketing system. Farm machinery - production, supply, demand, marketing and distribution, agro industries corporation and marketing of farm machines implements and equipments.

ABM 595 In-Industry Training 0+5 (NC)

Each student is required to undergo in-industry training in a business organization for six weeks. The purpose is to expose the students to the practical aspects of management. At the end of the training program, the student is required to submit a report. This report and the overall performance of the student in the organization form the basis of evaluation of student's work.

ABM 591 Seminar

ABM 600 Project Research

CHEMISTRY

PROGRAMMES

M. Sc.

Ph.D.

Five Year Integrated M.Sc. (Hons)

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Agrochemicals
Required Courses	Chem. 501, Chem. 502, Chem. 503, Chem. 504, Chem. 505
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Botany, Biochemistry, Microbiology, Mathematics, Statistics, Physics, Entomology, Plant Pathology, Soils, Agronomy or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Agrochemicals
Required Courses	Chem. 601
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Botany, Biochemistry, Microbiology, Mathematics, Statistics, Physics, Entomology, Plant Pathology, Soils, Agronomy or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduate Studies

Five Year Integrated M.Sc. (Hons)

Field of Specialization	Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Agrochemicals
Required Courses	All courses listed for Semester I-VI (P-___*) and Chem. 501, Chem. 502, Chem. 503, Chem. 504, Chem. 505.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Botany, Biochemistry, Microbiology, Mathematics, Statistics, Physics, Entomology, Plant Pathology, Soils, Agronomy or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

* Page number according to new RBI.

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses/ Integrated M.Sc. (Hons)

Chem. 91 Introductory Inorganic Chemistry 4+1 Sem. I

Basic concepts of chemistry: Classification and nature of matter, laws of chemical combination, Dalton's atomic theory: Concept of elements, atoms and molecules. Atomic and molecular masses and mole concept percentage composition, empirical and molecular formula, chemical reactions, stoichiometry and calculations based on stoichiometry. Atomic structure: Fundamental particles, Discovery of electron, proton and neutron, atomic number, isotopes and isobars, Thompson's model and its limitations, Rutherford and Bohr model of atom and limitations, concepts of shells and sub shells, dual nature of matter and light, de Broglie's relationship, Heisenberg principle, Quantum numbers, shapes of orbital's, rules for filling electrons in orbital's Aufbau principle, Pauli exclusion and Hund's rule and electronic configurations of elements, stability of half filled and completely filled orbitals. Classification of elements and periodicity in properties: Brief History of the development of the periodic table, Modern periodic law, Mendeleev's and modern periodic table, types of elements: s, p, d, f-block elements, periodic trends in properties; Atomic Radii, ionic radii, ionization energy and electron affinity and electro negativity, inert gas radii, ionization enthalpy, electron gain enthalpy, nomenclature of elements with atomic number greater than 100. Chemical bonding and molecular structure: Valence electrons, Ionic bond, bond parameters, Covalent bond, Lewis structure, polar character of covalent bond, Valence bond theory, Resonance, VSEPR theory, Concept of hybridization involving s, p and d orbitals and shape of some simple molecules. Molecular orbital theory of homonuclear diatomic molecules (qualitative idea only), hydrogen bond. States of matter: Three states of matter, Role of gas laws in elucidating the concept of the molecule, Boyle's Law, Charles law, Gay lussac's law, Avogadro's Law, Ideal behavior, empirical derivation of gas equation, Avogardro's number, ideal gas equation,. Derivation from ideal behaviour, kinetic energy and molecular speeds (elementary idea), derivation from ideal behaviour, Liquefaction of gases, Critical temperature Liquid state – Vapour pressure, Viscosity and surface tension. s-Block elements: General Introduction, occurrence, electronic configuration, diagonal relationship, trends in physical and chemical properties, such as ionization energy, atomic radii, trends in chemical reactivity with oxygen, water, hydrogen and halogens. Preparation and properties of some important compounds: Sodium carbonate, sodium chloride, sodium hydroxide and sodium hydrogen carbonate, calcium oxide and calcium carbonate p-Block Elements: Group 13 elements: Electronic configuration, occurrence, variation of properties, trends in chemical properties, Anomalous properties of first element of the group – boron; Preparation and properties of boron, borax, boric acid acid and boron halides, boron hydrides, aluminum; reactions with acid and bases. Group 14 elements:General introduction, occurrence, variation of properties, trends in chemical reactivity, Anomalous behavior of first element i.e. carbon – catenation, allotropic forms, important compounds of silicon; silicon tetrachloride, silicones, silicates and zeolites and their uses Group 15 elements: General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties; nitrogen; - preparation, properties and uses, compounds of nitrogen: preparation and properties of ammonia, nitric acid, oxides of nitrogen (structure only), Phosphorous-allotropic forms, compounds of phosphorous: preparation and properties of phosphine, halides (PCl_3, PCl_5) and oxoacids (elementary idea only) Group 16 elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties, dioxygen; preparation, properties and uses, simple oxides, Ozone, Sulphur - allotropic forms; compounds of sulphur; preparation, properties and uses of sulphur dioxide sulphuric acid: industrial process of manufacture, properties and uses, oxoacids of sulphur (structures only). Group 17 elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; compounds of halogens; preparation, properties and uses of chlorine and hydrochloric acid, interhalogen compounds,

oxoacids of halogens (structures only). Group 18 elements: (General introduction, electronic configuration. Occurrence, trends in physical and chemical properties, uses. d-and f-Block Elements: General introduction, occurrence electronic configuration, characteristics of transition metals, general trends in properties of the first row transition metals, metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation. Preparation and properties of $K_2Cr_2O_7$ and $KMnO_4$. Lanthanides-electronic configuration, oxidation states, chemical reactivity and lanthanide contraction.
Actinides - Electronic configuration, oxidation states. Coordination chemistry: Coordination compounds - introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds bonding; Werner's theory, VBT, CFT, isomerism, importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems). General principles and processes of Isolation of Elements: Principles and methods of extraction - concentration, oxidation, reduction electrolytic method and refining, occurrence and principles of extraction of aluminium, copper, zinc and Iron. Hydrogen: Position of hydrogen in periodic table, Occurrence, Isotopes, Preparation, properties, and uses of hydrogen, hydrides-ionic, covalent and interstitial, physical and chemical properties of water, heavy water, hydrogen peroxide, hydrogen as a fuel.
Practical: Introduction about basic laboratory techniques, crystallization of impure samples copper sulfate, alum, Quantitaive estimation: Preparation of a standard solution of oxalic acid, Determination of strength of a given solution of sodium hydroxide by titrating it against standard solution of oxalic acid, determination of molarity and strength of potassium permanganate solution by titrating it with standard solution of Mohr's salt, Determination of strength of a given solution of hydrochloric acid by titrating it against standard sodium carbonate solution. Chemical equilibrium: Study of shift in equilibrium between ferric ions and thiocyanate ions. Qualitative analysis: Determination of one anion and one cation in a given salt: Cations: Pb^{2+}, Cu^{2+}, As^{3+}, Al^{3+}, Fe^{3+}, Mn^{3+}, Ni^{2+}, Zn^{2+}, Co^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+.Anions: Co_3^{2-}, S^{2-}, SO_3^{2-}, SO_4^{2-}, NO_2^-,NO_3^-, Cl^-, Br^-, I^-, PO_4^{3-}, $C_2O_4^{2-}$, CH_3COO^-.

Chem. 92 Organic Chemistry-I **3+1** **Sem. II**

Some Basic Principles and Techniques in Organic Chemistry: General introduction, methods of purification, qualitative and quantitative analysis, Classification and IUPAC nomenclature of organic compounds. Electronic displacements in a covalent bond: inductive effect, electromeric effect, resonance and hyper conjugation. Homolytic and heterolytic cleavage of covalent bond, Reaction intermediates: structure and stability of free radicals, carbocations and carbanions, Concept of electrophiles and nucleophiles and types of organic reactions. Classification of hydrocarbons: Alkanes-Nomenclature, structure, isomerism, conformations(ethane only) physical properties methods of preparation and chemical reactions of alkanes, free radical mechanism of halogenation, combustion and pyrolysis of alkanes, Alkenes-Nomenclature structure of double bond (ethene) geometrical isomerism physical properties methods of preparation and chemical reactions: Addition of hydrogen, halogen, water, hydrogen halides (Markownikoff's addition and peroxide effect), ozonolysis, mechanism of electrophilic addition. Alkynes-Nomenclature, structure of triple bond (ethyne), physical properties, methods of preparation and chemical reactions, acidic character of alkynes and addition reaction of hydrogen ,halogen, hydrogen halides and water, Aromatic Hydrocarbons- Introduction, IUPAC nomenclature, resonance, benzene, aromaticity, chemical properties mechanism of electrophilic substitution reactions, – nitration, sulfonation, halogenations, Friedel Craft's alkylation and acylation: directive influence of functional group in mono-substituted benzene; carcinogenicity and toxicity. Environmental pollution- Air, water and soil pollution, chemical reactions in atmosphere, smog, acid rain, ozone and its reactions, Effects of depletion of ozone layer, greenhouse effect and global warming, industrial pollution, Green chemistry as an alternative tool for reducing pollution, strategy for control of environmental pollution.
Practical: Determination of melting point and boiling point of an organic compound, Crystallization of impure sample of benzoic acid. Preparation of aspirin, iodoform, analysis of fruits and

vegetable juices for their acidity, Detection of nitrogen, sulfur, chlorine in organic compounds, Test for the functional groups present in organic compounds:Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (primary) groups

Chem. 93 Fundamentals of Physical Chemistry 3+1 Sem. I

Solid state: Structure of ionic solids, close packed structure, classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea), unit cell in two dimensional and three dimensional lattices, calculation of density of unit cell, packing in solids, voids, number of atoms per unit cell in a cubic unit cell, points defects, electrical and magnetic properties imperfections in solids and silicates. Band theory of metals, conductors, semiconductors and insulators and n and p type semi-conductors. Solutions: Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, vapour pressure of solutions, Raoult's law, colligative properties; relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass and non-ideal solutions. Vant Hoff factor. Chemical energetic and laws of thermodynamics: Concept of system and its types, surrounding, work, heat, energy, extensive and intensive properties, state functions, first Law of thermodynamics, Internal energy, Enthalpy, Heat capacity, specific heat, measurement of ΔU and ΔH, Hess's law of constant heat summation, Enthalpy of bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization, solution and dilution, Introduction to entropy as a state function, Gibb's free energy change for spontaneous and non-spontaneous processes, criteria for equilibrium, second law of thermodynamics, third law of thermodynamics (brief introduction). Chemical equilibrium: Equilibrium in physical and chemical processes, dynamic nature of equilibrium, Law of mass action, Equilibrium constant, factors affecting equilibrium- Le Chatelier's principle, Ionic Equilibrium, Ionization of acids and bases, Strong and weak electrolytes, Degree of Ionization, ionization of polybasic acids, acid strength, Concept of pH, Henderson equation, Hydrolysis of salts (elementary idea), Buffer solutions, Solubility product, Common ion effects (with illustrative examples). Redox reactions: Oxidation and reduction, oxidation number and redox reactions in aqueous solution. Balancing redox reactions, Application of redox reactions. Chemical kinetics: Rate of reactions (average and instantaneous), order and molecularity of reactions; factors affecting rate of reactions; concentration, temperature, catalyst; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment)photochemical reactions and mechanism of reactions. Nuclear Chemistry: Natural radioactivity – discovery and historical development, Radioactivity, nuclear structure and properties, radioactive disintegration series, nuclear fusion and fission, group displacement law and nuclear reaction, rate of radioactive disintegration, artificial transmutation, breeder reactor, transuranic elements and applications. Synthetic and natural polymers: Classification, preparation and properties of natural and synthetic polymers and application of polymers. Surface chemistry: Concept of adsorption, physical and chemical; factors affecting adsorption of gases on solids; colloids; preparation and properties, colloidal state: distinction between true solutions, colloids and suspensions; lyophilic, lyophobic, multimolecular and macromolecular colloids, Tyndall effect, Brownian movement, catalysis, homogenous and heterogeneous, activity and selectivity, enzyme catalysis; electrophoresis, coagulation, emulsions types of emulsions. Electrochemistry: Redox reactions, conductance in electrolyte solutions, specific and molar conductivity, variation of conductance with concentration, Kohlrausch's law, electrolysis and laws of electrolysis (elementary idea) dry cells – electrolytic cells and galvanic cells, lead accumulators, EMF of a cell, standard electrode potential, Nernst equation and its applications to chemical cells, fuel cells, corrosion, relation between Gibbs energy change and EMF of a cell.

Practical: Preparation of lyophilic and lyophobic sol, determination of enthalpy of neutralization of strong acid and strong base, Determination of enthalpy change during interaction between acetone and chloroform, Enthalpy of dissolution of copper sulfate or potassium nitrate, study of

rate of Reaction between potassium iodate, KIO_3 and sodium sulphite : using starch solution as indicator, rate of reaction of ester hydrolysis, determination of molarity and strength of potassium permaganate solution by titrating it with standard solution of oxalic acid, determination of conductance of ions in a given sample, determination of refractive index of given liquids, determination of pH of given liquids using pH paper, universal indicator and pH meter, study of adsorption of oxalic acid on activated charcoal, study the viscosity and surface tension of the given liquids, determine the temporary and permanent hardness of water.

Chem. 94 Organic Chemistry-II **3+1** **Sem. II**

Haloalkanes and haloarenes: Nomenclature, nature of C-X bond physical and chemical properties mechanism of substitution reactions, optical rotation reactivity of C-X bond in haloalkanes and haloarenes, influence of halogen for monosubstituted compounds only) uses and environmental effects of Dichloro, Trichloro and Tetrachloromethanes, BHC, DDT, Freons and Iodoform. Alcohols: Nomenclature methods of preparation, physical and chemical properties (of primary alcohols only); identification of primary, secondary and tertiary alcohols; mechanism of dehydration, uses, with special reference to - methanol and ethanol. Phenols: Nomenclature methods of preparation, physical and Chemical reactivity of phenols in electrophilic substitutions, acidic nature of phenol, uses of phenols. Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses. Aldehydes and Ketones: Nomenclature, electronic structure of carbonyl group, methods of preparation, physical and chemical properties, and mechanism of nucleophilic addition, relative reactivity of aldehydic and ketonic groups, acidity of alpha-hydrogen, aldol condensation, cannizzarro reaction. Carboxylic acids and their derivatives: Nomenclature, electronic structure of-COOH, Important methods of preparation from aldehydes, ketones, alcohols and cyanides, physical and chemical properties, acidic nature, effect of substituents on alpha-carbon on acid strength, chemical reactions: Decarboxylation, etherification, Dehydration, relative reactivity of various acid derivatives and uses. Amines- Nomenclature classification, structure, primary, secondary and tertiary amines, methods of preparation, amination, Basic character of amines, chemical reactions, Methods to distinguish between Primary, Secondary and Tertiary amines, Dye test and Carbylamines reaction. Cyanides and isocyanides: Preparation from halides and Chemical reactions: Hydrolysis and reaction with Grignard's reagent. Diazonium salts: Preparation, chemical reaction of benzene diazonium chloride. And importance in synthetic organic chemistry. Some commercially important nitrogen containing carbon compounds (aniline and TNT). Nitro compounds: Nomenclature, Preparation from alkyl halides by nitration. Reduction reactions of nitro compounds. Biomolecules: Carbohydrates: Classification, aldose and ketose, monosaccharides (glucose and fructose), oligosaccharides (sucrose, lactose, maltose), polysaccharides, starch, cellulose, glycogen); Important simple chemical reactions of glucose, elementary idea of structure of pentose and hexose. Proteins: Elementary idea of alpha-amino acids, peptide bond, polypeptides, proteins, primary, secondary, tertiary and quaternary structure, Denaturation of proteins, Enzymes. Vitamins: Classification and Functions, Hormones: Elementary idea (excluding structure) Nucleic acids: Chemical composition of DNA and RNA, Lipids: Classification and Structure, Polymers: Classification - natural and synthetic, Addition and condensation polymerization, copolymerization, natural rubber, vulcanization of rubber, Synthetic rubbers, Condensation polymers,. Some commercially important polymers (Polythene, polyesters, rubber, PVC, teflon, polystyrene, nylon-6 and 66, terylene and bakelite). Biodegradable and Non-Biodegradable Polymers. Chemistry in everyday life: Chemicals in medicines, analgesic, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines. Chemicals in food – Preservatives, artificial sweetening agents. Elementary idea of antioxidants. Cleansing agents – Soaps and detergents, Cleansing action.

Practical: Separation of pigments from extracts of leaves and flowers by paper chromatography and TLC and determination of R_f values. Preparation of Organic Compounds: Acetanilide, azo dye, iodoform, urea-formaldehyde resin, study the cleansing action of different detergents, Test for the functional groups present in organic compounds: Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino(primary) groups. Study of carbohydrates, fats and

proteins in pure form and detection of their presence in given food stuffs.

Chem. 101 General Chemistry **2+1 (NC)** **Sem. I**

Atomic structure, Rutherford's model and Bohr's atomic model, Quantum mechanical concept of atomic structure. Concept of orbitals, their shapes, Quantum numbers. Chemical bonding including ionic, covalent and co-ordinate bonds. Trivial and modern periodic table studies. Chemical energetics. Chemical equilibrium. Chemical kinetics; rate of reaction and order of reaction. Acids, bases, salts, pH, common ion effect, buffer solutions, their preparation and use in intracellular fluids. Hydrolysis of salts of strong acid and strong base, strong acid and weak base, weak acid and strong base, weak acid and weak base and solubility product. Elementary ideas about colloids, surface chemistry and catalysis, electrochemistry. Corrosion, its electrochemical theory and its prevention.

Practical: Analysis of a single salt. Volumetric analysis, involving acid-alkali titration and redox titration. Determination of pH and electrical conductivity. Heat of neutralization.

Chem. 102 Introductory Organic Chemistry **2+1** **Sem. I**

Introduction to organic chemistry. IUPAC nomenclature of carbon compounds and their isomerism in carbon compounds, hybridization, sp3 , sp^2 and sp, their shapes and angles, explanation of acidity of alkynes. Preparation and properties of alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, aliphatic aldehydes and ketones, aliphatic carboxylic acids and their derivatives and aliphatic amines. Introduction to aromatic compounds. Structure of benzene, aromatic hydrocarbons, preparation and properties of benzene, aryl halides, phenol, aniline, benzene sulfonic acid, benzaldehyde, acetophenone, benzoic acid. Chemistry of esters, amides, acid chlorides, cyanides and isocyanides, An introduction to substitution and elimination reaction, carbocations, carbanions and free radicals.

Practical: Detection of elements. Tests for functional groups. Determination of melting and boiling points. Preparation of dyes, soap and detergent.

Chem. 201 Organic Chemistry **3+0** **Sem. I**

Structure of benzene, heats of hydrogenation and combustion (stability), carbon-carbon bond length, resonance, orbital picture and Huckel rule of aromaticity. Aromatic substitution reactions and their mechanism involving nitration, halogenations, sulfonation, Friedal- Crafts acylation and alkylation. Reactivity and orientation, theory of reactivity and orientation. Aromatic- aliphatic compounds - arenes and their derivatives. Preparation and important reactions of aromatic aldehydes, ketones, carboxylic acids and their derivatives, halides and phenols. Nitrobenzene and its reduction products. Diazonium salts and their synthetic applications. Nucleophilic aromatic substitution. Polynuclear aromatic compounds, nomenclature, structure, reaction and orientation of electrophilic substitution in naphthalene, anthracene and phenanthrene and their derivatives. Synthesis and structure, reactions and aromatic character of furan, pyrrole, thiophene and pyridine. Electrophilic substitution in five and six membered aromatic heterocyclic compounds. Chemistry of malonic ester and acetoacetic ester. General introduction to photochemistry.

Chem. 202 Chemistry for Agricultural Engineering **2+1** **Sem. II**

Phase rule and its application to one and two component systems. Fuels, classification and calorific value. Colloids, classification and properties. Corrosion and its prevention. Pollution sources and types of pollution. Analytical methods like thermogravimetric, polarographic analysis, nuclear radiation detectors and analytical applications of radioactive materials. Metallurgy of titanium, nickel and chromium. Lubricants, properties, mechanisms, classification and tests. Polymers, nomenclature, types of polymerisation, effect of structure on properties, mechanical behavior, plastic and elastomers. Resins, determination of molecular weight of polymers.

Practical: Volumetric, Gravimetric and Instrumental analysis. Water: Total solids, turbidity, pH value, carbonate and bicarbonate, acidity, hardness, chloride, dissolved oxygen, BOD, COD,

ammonical nitrogen, coagulant, chlorine demand and residual chlorine. Chemical analysis of cement and alloys. Viscosity of bitumen, calorific value of fuels, polarimetric, conductometer and spectrophotometric analysis.

Chem. 203 Physical and Inorganic Chemistry 2+1 Sem. II

Law of thermodynamics, concept of free energy, Partial molar quantities, chemical potential, Kirchhoff's equation. Application of thermodynamics in understanding energies in living cells. Differential rate law and integrated rate expression. Half life time of a reaction. Concept of activation energy. Reaction mechanism, steady state hypothesis. Catalysis: Homogenous catalysis, enzyme catalysis, Heterogeneous catalysis unimolecular surface reaction. Debye-Huckel theory of strong electrolytes, Transport number, Polarography, Half wave potential. The Schrödinger equation and postulates of quantum mechanics, Normal and orthogonal wave function, solution of Schrödinger wave equation for one and three dimensional box. Metal - ligand bonding in transition metal complexes, magnetic properties of transition metal complexes. Thermodynamic and Kinetic aspects of metal complexes. Hard and soft acids and bases. Organometallic compounds.

Practical: Separation and identification of ions (4-ions with no interference), Preparation of metal complexes, Experiments involving conductometer, pH meter, spectrophotometer, refractometer, polarimeter. Experiments concerning adsorption, solutions and chemical kinetics.

Chem. 204 Mechanism of organic reactions 2+1 Sem. II

Types of organic reactions, Reaction intermediates, assigning formal charges on intermediates and other ionic species. Methods for determination of reaction mechanism (product analysis, intermediates, isotope effect, kinetic and stereochemical studies).Mechanism of free radical halogenation of alkanes; orientation, reactivity and selectivity. Aromatic Electrophilic Substitution-Mechanism of nitration, halogenation, sulfonation and Friedel craft reaction. Concept of isomerism, types of isomerism (optical, geometrical and conformational isomerism) stereoselective and stereospecific reactions. Stereochemistry of addition of halogens to alkenes, Stereochemistry of elimination reactions. Spectroscopy: Introduction to infrared, ultraviolet visible and proton NMR spectroscopy. Use of these spectroscopic techniques for structural elucidation.

Practical: Use of chromatography in the separation and identification of organic compounds in a mixture. Identification of elements and functional groups in organic compounds. Single step preparation of organic compounds.

Chem. 205 Engineering Chemistry 2+1 Sem. I

Phase rule and its application to one and two component systems. Fuels: classification, calorific value. Colloids: classification and properties. Corrosion: causes, types and methods of prevention. Water; temporary and permanent handness, disadvantages of hard water, scale and sludge formation and corrosion in boiler. Analytical methods like thermogravimetric, polarographic analysis, nuclear radiation, detectors and analytical applications of radioactive materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Principles of food chemistry, introduction to lipids, proteins, carbohydrates, vitamins, food preservators, coloring and flavoring reagents of food. Lubricants; properties, mechanism, classification and tests. Polymers: types of polymerization, properties, uses and methods for the determination of molecular weight of polymers. Introduction to IR spectroscopy.

Practical: Determination of temporary and permanent hardness of water by EDTA method. Estimation of chloride in water. Estimation of dissolved oxygen in water. Determination of BOD in water sample. Determination COD in water sample. Estimation of available chlorine in bleaching powder. Determination of viscosity of oil. Estimation of activity of water sample. Estimation of alkalinity of water sample. Determination of carbonate and non-carbonate hardness by soda reagent. Determination coagulation of water and chloride ion content. Determination of specific rotation of an optically active compound. max and verification of Lambert Beer's Law. Determination of calorific value of fuel.λDetermination of Identification of functional groups

(alcohol, aldehyde, ketone, carboxylic acid and amide) by IR. Chromatographic analysis. Determination of molar refraction of organic compounds.

Chem. 301 Fundamental Organic Chemistry 3+0 Sem. I

Classification, nomenclature and preparation of alkyl halides. Mechanism, kinetics, stereochemistry, role of solvents in substitution and elimination reactions. Homogenous hydrogenation in alkenes and its stereochemistry. Mechanism and orientation of free radical addition and substitution in alkenes. Allyl radical, its stability and orbital picture. Electrophilic addition to conjugated dienes. Introduction, structure, classification and nomenclature of alcohols. Orientation, stereochemistry and mechanism of hydroboration reaction. Study of stereochemistry, intramolecular nucleophilic attack, Anchimeric effect in the cleavage of C--OH bond of alcohols, biological oxidation of ethanol. Chemistry of benzene, the Huckel 4n+2) rule. Structure, nomenclature and chemistry of aldehydes and ketones. Alkylation of carbonyl compounds via enamines. Preparation of ketones by Friedel-Crafts acylation and use of organocopper compounds. Pinacol rearrangement, acetal formation and Cannizzaro reaction. Ionization, acidity constant, equilibrium, acidity, effect of substituents on acidity of carboxylic acids. Grignard's synthesis and reactions of carboxylic acids. Aldol condensation.Witting reaction, Claisen condensation, Reformatsky reaction. Structure, classification nomenclature and chemistry of amines and phenols.The chemistry of sulfa drugs and diazonium salts. Syntheses and chemical reactions of malonic acid and acetoacetic acid. Chemistry of naphthalene, anthracene and phenanthrene.

Chem. 302 Chemistry of Agrochemicals, Plant Products and Growth Regulators 1+1 Sem. I

Organic chemistry as prelude to agrochemicals. Diverse types of agrochemicals. Botanical insecticides (neem), pyrethrum and synthetic pyrethroids. Synthetic organic insecticides, major classes, chemistry and use of some important insecticides under each class. Herbicides-major classes, chemistry and use of 2,4-D, atrazine, glyphosate, butachlor, benthiocarb. Fungicides - major classes, Chemistry and use of carbendazim, carboxin, captan, tridemorph and copper oxychloride. Plant growth regulators.

Practical: Argentometric and iodometric titrations - their use in the analysis of important pesticides. Compatibility of fertilizers with pesticides.

Chem. 303 Thermodynamics and Chemical Kinetics 3+0 Sem. II

Types of system, state and path function. First law of thermodynamics, Heat capacity Cp and Cv, Kirchoff's equation, calculation W, q, dU and dH for expansion of ideal gas under isothermal and adiabatic conditions, Joule Thomson effect, Joule Thomson coefficient, Zeroth law of thermodynamics, Absolute temperature scale. Second law of thermodynamics, Carnot cycle, concept of entropy and third law of thermodynamics, Nernst heat theorem, Concept of residual entropy. Gibb's function (G) Helmholtz function (A), variation of G & A with P, V and T, Claussius inequality, Entropy change in mixing of ideal gases. Entropy as a function of V and T, Entropy as a function of P and T. Chemical kinetics, Factors influencing reaction rate, Mathematical derivation of rate equation for zero, first and second order reactions, half life, Pseudo unimolecular reactions. Homogeneous and heterogeneous catalysis, Acid base & enzyme catalysis, Michaelis Mentan equation for enzyme catalysis.

Chem. 304 Basic Analytical Chemistry 3+0 Sem. II

Accuracy and precision, Significant figures, determinate and indeterminate errors. Chromatography, types of chromatography, High performance liquid chromatography, principle, instrumentation and its applications, Paper chromatography, Thin layer chromatography, Column chromatography and Gas liquid chromatography.Conductometric methods; Measurement of conductance, Conductometric titrations and variation of equivalent conductance with dilution. Analytical reagents, EDTA, cerate and Iodate. Gravimetric analysis, Examples, organic

precipitates, precipitation equilibria and diverse ion effect. Colorimetry-Introduction, derivation of Beers law, Applications of colorimetry and spectrophotometry. Potentiometric titrations, types of potentiometric titrations, Advantages of potentiometric titrations. pH, Ion selective electrode, Instrumentation, application of pH measurements. Electrogravimetry, theory, instrumentation and applications.

Chem. 305 Experiments in Inorganic Chemistry 0+2 Sem. II

Quantitative analysis of inorganic mixture of four (4) ions with one interfering anion. Chromatographic separation of Cl^- , Br^- and I^- ; Cd^{2+} and Hg^{2+}. Colorimetric determination of Ni as Ni-diglyoxime complex, Pb as dithiazone complex and Al (or Mg) as oxinate complex. Preparation of aluminium acetylacetonate, Cu (I) thiourea, Potassium trioxalato chromate (III) and Mohr's salt.

Chem. 306 Fundamental Inorganic Chemistry 2+0 Sem. I

SBlock elements; oxides, hydroxides, hydrides, halides, solvation and complexation tendencies, crown and cryptans. p Block elements; variation of periodic properties, oxides, oxoacids, hydrides and halides, preparation and structure of boranes, structure of silicates, silicones, phosphazenes, compounds of sulphur and nitrogen. Preparation and properties of inter halogen compounds, clathrates. Structure, properties and preparation of noble gas compounds. Non aqueous solvents, liquid ammonia, sulfur dioxide and hydrogen fluoride as solvents, characteristic properties and reactions. Acids and bases, Bronsted Lowry, Lewis and Pearson's concepts of acids and bases, HSAB principle and its application.

Chem. 308 Chemistry of Agrochemicals 2+1 Sem. II

Agrochemicals- introduction, types, role in agriculture, effect on environment, soil, human and animal health, merits and demerits of uses in agriculture. Management of agrochemicals for sustainable agriculture. Herbicides-major classes, properties and fate of important herbicides. Classification of fungicides. Inorganic fungicides - characteristics, preparation, use and mode of action of bordeaux mixture and copper oxychloride. Organic fungicides- mode of action, characteristics, preparation and use of dithiocarbamates- zineb and maneb. Systemic fungicides-characteristics and use of benomyl, carboxin, oxycarboxin, metalaxyl, carbendazim. Introduction and classification of insecticides-inorganic and organic insecticides. Uses of organochlorine, organophosphates, carbamates, synthetic pyrethroids neonicotinoids. Insecticide act and rules. Banned, withdrawn and restricted use insecticides. Insect growth regulators (IGRs), biopesticides, reduced risk insecticides-botanicals. Plant and animal systemic insecticides. Fertilizers and their importance. Nitrogenous and phosphatic fertilizers-feedstocks and manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea, slow release N-fertilizers and single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers- natural sources of potash, manufacturing of potassium chloride, potassium sulphate and potassium nitrate.Mixed and complex fertilizers- sources and compatibility. Preparation of major, secondary and micronutrient mixtures. Complex fertilizers-manufacturing of ammonium phosphates, nitro phosphates and NPK complexes. Fertilizer control order. Fertilizer logistics and marketing. Plant bio-pesticides for ecological agriculture, Bio-insect repellents.

Practical: Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for the identification of common fertilizers. Identification of anions and cations in fertilizers. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticides available in market. Estimation of nitrogen in urea, water soluble P_2O_5 and citrate soluble P_2O_5 in single super phosphate, potassium in muraite of potash/ sulphate of potash (by flame photometer), copper in copper oxychloride and sulphur insulphur fungicide- thiram and ziram

Chem. 421 General Physical Chemistry 2+1 Sem. I

Liquification of gases. Colloids, preparation and properties, Zeta potential. Emulsions. Adsorption and adsorption isotherms. Applications of colloids and adsorption. Macromolecules, types and

molecular weight determination. Chemical and ionic equilibria, acids, bases, pH, buffer solutions and Handerson equation. Salt hydrolysis and calculation of hydrolysis constant and pH of various types of salts. Solubility product, ionic product and concept of precipitation and its applications. Theories of indicators. Photochemistry, Norrish-I, Norrish-II, Florescence, Phosphorescence, concept of singlet and triplet oxygen and Jablonski diagram. Introduction to Infra Red, UltraViolet-Visible, Raman, Nuclear Magnetic Resonace spectroscopy and Flame photometry.
Practical: Verification of adsorptions, isotherms, charge on colloidal particles, molecular weight of polymers, preparation of buffer solutions, determination of pKa. Spectrophotometric analysis. Determination λ_0 . Verification of Oswald's dilution law.

Chem. 422 Electrochemistry and Surface Chemistry 3+0 Sem. II
Electrolytic conductance and Debye-Huckle theory. Activity coefficient of electrolytes and Debye limiting law. Electrochemical cells. Liquid junction potential. Equilibrium constant and EMF and its determination using different electrodes. Potentiometric titrations, overvoltage and polarography. Adsorption at solid/ gas interface, monolayer adsorption. BET equation and its applications. Heat of adsorption. Adsorption from solutions and calculation of surface area of solid from adsorption. Adsorption at liquid/gas interface. Chemisorption and catalysis. Kinetics of surface reactions.

Chem. 423 General Organic Chemistry 2+0 Sem. I
Introduction to mechanism of various organic reactions including reaction intermediates, carbocations, carbanions, free radicals, carbenes and benzynes. Stereochemistry, optical activity, chirality, compounds with one or more chiral centres, enatiomers, diastereomers, nomenclature and assignment of configurations to simple molecules including RS, EZ, and DL. Conformations of acylic and cyclic systems including staggered, anti, gauche and chair and boat forms. Chemistry of heterocyclic compounds, thiophenes, furan, piperidine, pyridine, pyrrole, pyran. Chemistry of oils, fats and carbohydrates.

Chem. 424 Radioactivity and Transition elements 2+0 Sem. I
Discussion of f blocks elements, lanthanides, actinides, lanthanide contraction, actinide contraction and its effects, separation of lanthanides and actinides, simple chemistry of elements like Francium, Technetium and Rhenium. Separation of inner transition elements, their salts and uses. Atomic nuclei, binding energy and stability of isotopes. Natural and induced radioactivity, kinetics and half life of radioactive elements, units of radioactivity, Carbon dating, transuranic series. Tracers and their applications. Acid-base concept, hard and soft acids and bases and the application of this concept. Role of transition elements in biological systems.

Chem. 425 Introduction to Metal Complexes and Chelates 2+1 Sem. II
Metal complexes and metal chelates, Pauling electronegative principle, hydration energy, inter ligand repulsion, weak metal ligand bonding, strong ligand bonding, back bonding and its effect on stability of complexes. Study of charge transfer complexes. Nomenclature and isomerism. Structure and nature of bonding in complexes. Stability and reactivity in metal complexes and factors influencing stability. Substitution reaction and Trans effect. Electronic spectra of metal complexes, magnetic properties of complexes. Role of metal complexes and metal chelates in transportation of micronutrients in plants, role of iron, manganese and copper complexes in plants and animals.
Practical: Spectrophotometry, pH metric studies in relation to stability constants of metal ligand systems.

Chem. 426 Chemistry of Non-transition Elements 2+0 Sem. I
Organometallic compounds of magnesium and copper and their synthetic utility, Latimer and Volt-equivalent diagrams, silicates, iso and heteropolyacids, boron hydride and related compounds, boron halides/sulfurnitrogen cyclic compounds. Phosphates, oxy acids of nitrogen, phosphorous and sulfur and trends in their acidity and reduction potential, Ellingham diagram, Use of

compounds of selenium and their toxicity. Xenon compounds, oxy and flouro derivatives of xenon, their synthesis and chemical reactions structure of silicates and borates.

Chem. 427 Spectroscopy and Structure Elucidation 2+0 Sem. II

General introduction to principles and theory of various spectroscopic techniques, Infrared (IR) spectroscopy, group absorption, sampling techniques and interpretation of spectra. Nuclear magnetic resonance (1 H NMR and13C NMR), Continuous wave (CW) and Pulsed Fourier Transform (FT) spectrometry, Chemical shift, Spin coupling, Chemical shift equivalence, Coupling constant, and Relaxation time. Difference in CW and FT techniques. Solvent shift and lanthanide shift studies. Theory and application of Ultraviolet spectroscopy, chromophore, auxochrome and red and blue shift, Study of Woodward rules and calculation max of highly conjugated compounds like carotene and lycopene. Mass spectrometry, molecular ion peak, base peak, fragmentation pattern of simple molecules, hydrocarbons, alcohols, ethers alicyclic and cyclic ketones, aldehydes and McLafferty rearrangement. Combined use of spectroscopy for structural elucidation of simple organic compounds.

Chem. 428 Experiments in Chemistry 0+3 Sem. II

Use of viscosity and surface tension to determine composition of two liquids and molecular weight of high polymer by viscosity, Use of Stalagmometer. Determination of distribution coefficient of iodine between carbon tetrachloride and water. Water equivalent of Dewar's flask and neutralization of hydrochloric acid. Conductometric titration of strong acid with strong base, strong acid with weak base, weak acid with strong base and weak acid with weak base. Solubility of lead sulfate in water and adsorption of acetic acid by activated charcoal. Detection of elements (N, S and halogens) and functional groups (- COOH, $-CONH_2$, C= O, -CHO, $-NH_2$ and aromatic - OH). Identification of simple organic compounds and preparation of their derivatives. Preparation of tribromophenol, benzillic acid, acetanilide, acetamide, mdinitrobenzene, benzoic acid and oxalic acid and isolation of caffeine. Estimation of phenol and aniline by bromide-bromate and acetylation methods. Equivalent weight of an acid by neutralization method.

Chem. 429 Drugs, Bimolecules and Polymers 3+0 Sem. II

Classification, preparation, uses and mechanism of action of antipyretic and analgesics, sulfa-drugs, antimalarials and some trivial and modern antibiotics. General introduction to simple terpenes (occurrence, isolation, classification and Isoprene rule). Alkaloids, occurrence, importance, general structural features and Hoffmann exhaustive methylation. Structural aspects of sucrose, starch and cellulose. Methods of preparation, physical properties, dipolar nature, chemical reactions and configuration of amino acids. Peptide-linkage, peptide synthesis and structure of polypeptides. General characteristic and secondary structure of proteins. General introduction to polymers, Types of polymers and polymerization process, Polymerization under radical, ionic and coordination and their mechanism. Chemistry of natural and synthetic polymers, synthetic fibers, plastics, foaming agents (plasticizers) and biodegradable polymers.

Chem. 430 Fundamental Quantum and Solution Chemistry 3+0 Sem. II

Elementary quantum mechanics, Black body radiation, Photoelectric effect, Bohr's model and its drawbacks, de Broglie hypothesis, Heisenberg's uncertainty principle, postulates of quantum mechanics. Schrödinger's wave equation, physical interpretation of wave function, particle in one dimensional box and three dimensional box, Schrödinger's wave equation for H atom, radical distribution function, Quantum numbers, n, l, m and their importance, Eigen value and eigen function, Hamiltonian operator, physical interpretation of wave function. Molecular orbital theory, Formation of molecular orbital by linear combination of atomic orbital, Calculation of energy levels from wave functions, Physical pictures of bonding and antibonding wave function. Colloids, preparation and properties. Zeta potential, emulsion, ionic equilibria, acids and bases, pH, buffer solution and Henderson's equation, salt hydrolysis, solubility product and its application. Adsorption and adsorption isotherms. Applications of adsorption, difference between physical and

chemical adsorption.

Postgraduate Courses

Chem. 501 Thermodynamics and Electrochemistry 3+0 Sem. I

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. Phenomenological equations. Membrane permeability, membrane transport involving biochemical reaction. Phenomenological equation in non-linear regions. Thermodynamics of living systems, metabolic and biosynthetic reaction, ATP production during biochemical process of various types, applications of irreversible thermodynamics in biological processes. Debye-Huckel theory. Debye-Onsager theory of conductance. Activity coefficients and their determination. Electro-kinetic and electro capillary phenomena. Theories of electrical double layer at the electrodeelectrolyte interface. Over potential, exchange current density, derivation of Butler-Volumer equation. Tafel plot. Electrocatalysis. Hydrogen electrode. Polarography, theory, II-Kovic equation, half wave potential and its significance.

Chem. 502 Spectroscopy 2+1 Sem. I

Molecular structure-molecular orbital methods for H_2 and H_2 molecule, the valence bond description 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, Laser Raman Spectroscopy. Nuclear Magnetic Resonance Spectroscopy, FTNMR. Mass spectroscopy.
Practical: Application of spectroscopy for structural studies. Determination of structure of simple compounds by the combined use of UV, IR , NMR and Mass spectroscopy; use of double irradiation, solvent shift experiments on compounds having hydroxyl groups, inter and intra hydrogen bond studies by FT-IR.

Chem. 503 Basic Concepts of Inorganic Chemistry 2+0 Sem. I

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 functions for s, p, d and f orbitals-their significance and use. Slater-type orbitals; effective nuclear charge, use of radial distribution curves to explain order of filling of orbitals in many electron systems, 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. Bio-inorganic chemistry, photosynthesis, metalloenzymes.

Chem. 504 Physical Organic Chemistry 2+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 carbocation ions. Neighboring group participation, pericyclic reactions and molecular orbital symmetry

Chem. 505 Natural Product Chemistry 2+0 Sem. II

Structures and synthesis of terpenes-geraniol, citral amyrins, 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 and cortisone. Plant hormones, auxins, kinetin, abscisic acid and gibberellins. Alkaloids, structural determination, quinine, atropine, reserpine, morphine, nicotine, epherdrine, cocaine. Acetogenins, anthocyanins, flavones, flavonoids, isoflavones, chalcones. Coumarins, euxanthones, biogenesis of flavonoids, porphyrins, haemin and chlorophyll. Structures of starch and cellulose.

Chem. 506 Experiments in Physical Chemistry 0+2 Sem. II

Practical: Conductivity, potentiometry, pH metry, polarography, amperometric titration, spectrophotometry, flame-photometry, cryoscopic and ebullioscopic measurements; Chromatography. Adsorption studies, optical activity by polarimer, refractive index and molar refraction of different solvents. Electron polarization of liquids refractrometrically, Kinetic studies.

Chem. 507 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. 508 Chemical Kinetics and Surface Chemistry 2+0 Sem. II

Theories of reaction rates, collision theory, transition state theory, theory of unimolecular reactions, Lindermann's mechanism, rate constants of fast reactions-relaxations, stop-flow and flash photolysis techniques. Mechanism of free radical reactions, hydrogen-bromine reaction, photochemical decomposition, polymerization, explosion, ionic reactions. Complex reactions-electron transfer reactions, consecutive, opposing reactions, kinetics of catalytic reactions, acid base catalysis, effect of pH and salt effects. Enzymes, catalysis, absorption-type of absorption. Freundlich's absorption isotherm, Langmuir's adsorption isotherm and its limitations. BET adsorption isotherm, chemical sorption, kinetics of surface reaction and their mechanism.

Chem. 509 Co-ordinate Chemistry, Reaction Mechanism and Inorganic Polymers 2+1 Sem. I

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, John-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 heteroatom structures. Polymers containing boron and nitrogen, addition polymers of borazines, polymeric phosphorus compounds and condensed phosphates.

Practical: Preparation of inorganic complexes like $Co\{Hg(SCN)_4]$, $Hg[Co(SCN)_4]$, $[Co(NH_3)_5NO_2]Cl_2$, $Co(NH_3)_5Cl]Cl_2$, $[Cu(Gly)_2]$, $K_2\ [Cu(C_2O_4)_2]$, $[Co(acac)_3]$, $K_4\ [Co_2(C_2O_4)_4(OH)_2]$, $[Co(NH_3)_4]SO_4$ and $Na_3[Co(NO_2)_6]$. Determination of magnetic characteristic of above complexes. Analysis of alloys using conventional, physical and chemical techniques. Complex metric titrations.

Chem. 510 Synthesis and Characterization of Organic Compounds 0+2 Sem. II

Practical: Separation and identification of the components of a binary organic mixture. Synthetic preparations involving two steps. Quantitative analysis of phenol, aniline. Quantitative analysis of

sulphur, nitrogen, phosphorous. Isolation of essential oils from rose, ajwain, mentha and eucalyptus.

Chem. 511 Chemistry of Agrochemicals I **2+1** **Sem. I**

Classification of pesticides on the basis of function, mode of entry and mode of action, chemistry and structural activity relationship of different pesticides. Insecticides-organochlorines, organo-phosphates, carbamates, pyrethroids, rotenones fumigants and botanicals. Fungicides-Inorganics, dithiocarbamates, Diazoles and Exothions. Herbicides-phenoxy compounds, substituted ureas, sulfynyl ureas, triazines, bipyridylium compounds and dinitroanilines. Metabolic pathways of some important compounds of each chemical group. Chemistry of fertilizers.

Practical: Testing of pesticide formulations for quality, Estimation of active principles of pesticides employing different analytical techniques in different matrices, Determination of pesticide residues in different commodities by chemical and instrumental methods, analysis of fertilizers.

Chem. 512 Reaction, Reagents and Photochemistry **3+0** **Sem. II**

Beckmann, Claisen, Fries, Wagner-Meerwein rearrangement, Claisen condensation, Deckmann, Reformatsky, Curtius, Friedel-crafts, Mannich, Michael, Perkin, Kolbe's, Reimer-Tiemann, Hofmann, Diels Alder, Arndt Eistert, Wittig reactions, Aldol condensation, Benzilic acid and Benzidine rearrangements, Acetoacetic, Malonic ester and Grignard synthesis. Reagents in organic synthesis- Cu, CuX, Zn, Mg, Li, $ZnCl_2$, $AlCl_3$, $Al(OR)_3$, $LiAlH_4$, Na, RONa, Ni, SeO_2 , BX_3 , $NaBH_4$, CH_2 N_2, HIO_4 . Organometallic compounds. Photochemistry-Energy levels, quantum yield, photochemistry of simple organic molecules, Barton reaction.

Chem. 513 Chemistry of Transition Metals **2+0** **Sem. I**

Transition elements-Hund's rule and spectroscopic energy states, magnetism in transition metal chemistry, origin and nature of paramagnetism, diamagnetism, ferromagnetism and anti-ferromagnetism. Magnetic susceptibility and magnetic moment calculations, elements of second and third row transition series, chemistry of iso- and heteropolyacids and anions of Mo and W, the metal-metal bonds. General remarks on different physical and chemical properties of compounds with two centered metal-metal bonds; metal clusters, occurrence, electronic structure, oxidation states and stereo chemistry. Magnetic and spectral properties of lanthanides and actinides, lanthanides contraction separation of lanthanides and actinides. Chemistry of rare elements francium, technitium, rhenium.

Chem. 514 General Physical and Colloidal Chemistry **3+0** **Sem. I**

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 of 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 and 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, interfacial phenomena, practice kinetics, electrical properties, viscosity. Lyophobic and lyophilic solutions, gels and emulsions developed from above properties.

Chem. 515 Chemistry of Agrochemicals II **2+1** **Sem. II**

Definition, importance, scope, basic principle of pesticide toxicology and its relationship with other disciplines. Structure, metabolism and mode of action of insecticides. Plant growth regulators. Role of chelates in micronutrient transport. Recent trends in the development of agrochemicals. Evaluation of insecticide toxicity, joint action of insecticide, synergism and factors affecting toxicity of insecticides. Insecticide residues, their extraction, cleanup and estimation. Significance and environmental implications of insecticide residues. Insecticide act, registration and quality control

of insecticides, safe use of insecticides.
Practical: Preparation of working standard solutions of pesticides. Sampling, extraction, cleanup and estimation of insecticide residue by chemical and instrumental methods, calculations and interpretation of data.

Chem. 601 Special Topics in Chemistry 3+0 Sem. II
Role of protective groups in structural and synthetic studies. Procedure for introduction of functional groups of remote positions. Recent bis and tris annulation reactions. Recent oxidative and reductive techniques and their use in organic synthesis. Future trends in agrochemrcials. Oxide glasses, organosilicon compounds, metallocarboranes, lower oxidation states, super heavy metals, metal carbon bond and catalysis, role of metal ions in various biological processes and inorganic drugs, inorganic free radicals. Onsager reciprocal relation, entropy production, electrokinetic effects, diffusion, thermocells, thermomolecular pressure and thermoosmosis reactions. Theories of liquid crystals, principles of group theory and its applications to spectroscopy and quantum mechanics.

Chem. 602 Advanced Physical Chemistry 3+0 Sem. II
Application of computers in Chemistry, Advanced quantum mechanics, Pauli's exclusion principle, interaction energy of electrons, method of directed valence bonds, molecular orbitals and valence, Application of statistical mechanics to reaction rates and intermolecular forces, Spectroscopy and solid state chemistry.

Chem. 603 Organometallic Chemistry 3+0 Sem. II
Introduction, synthesis and structure of metal alkyls, metal aryls, metal carbonyls, metal carbenes and metal carbines. Complexes with chain pi donor ligands and cyclic pi donor ligands, reaction path ways, association reactions, Substitution reactions, addition and elimination reactions, rearrangement reactions. Catalysis involving organometallic compounds-olefin hydrogenation, hydroformylation and the Wacker process. Polymerization, Fischer-Tropsch process, Cyclo-oligomerisation of olefins and acetylenes. Role of advanced spectroscopy in structure elucidation of complex organic compounds.

Chem. 604 Bio-inorganic Chemistry 3+0 Sem. I
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, porphyrin. Oxygen carriershemocyanin and haemoerythrin, synthetic oxygen carriers, non-redox metallo-enzymes. Mechanism of electron transfer reactions in metal complexes as drugs and anticancer agents.

Chem. 605 Organic Synthesis and Spectroscopy 3+0 Sem. II
Transition-metal mediated carbon-carbon bond formation. Use of organosilicon, organoboranes, organopalladium and organolithium in organic synthesis. Stereo-, regio- and chemo-selectivity in organic synthesis. Recent advances in the field of organic chemistry and other topics of current interest. Role of activated metals and ultra-sound in organic synthesis. Role of double irradiation, solvent effect, lanthanide induced shift reagents, NOE, COSY, NOSY in structural elucidation. Problems related to the use of 1 H, 13CNMR and mass spectroscopy.

Chem. 606 Constitution of Inorganic Compounds and Dynamics of Inorganic Reactions 3+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. 607 Green Chemistry **3+0** **Sem. I**

Concept of green chemistry. Chemistry and chemical technology of waste, pollution, effluent and other environmental issues which are caused by chemical manufacturing. Novel synthetic techniques. Organic reactions involving reduction of raw material/solvent usage, milder operating conditions. Use of catalyst towards green chemistry. Reactions that use heterogeneous or homogeneous catalyst leading to green scenario. Use of biocatalyst in reactions which make environment clean and friendly. Use of new reagents and solvents which are benign, environmentally friendly. Method of benign synthesis. Energy and renewable resources. Alternate energy sources. Use of renewable raw material includes ethanol, bio-diesel, etc.

Chem. 608 Advances in Agrochemicals **3+0** **Sem. I**

Chemistry of new molecules, imidacloprid, spinosad their structure, properties, mode of action, toxicity, efficacy and dissipation behavior. Plant growth regulators. Repellants, attractants, pheromones, synergists, synthetic inhibitors and proinsecticides, chemosterilants, defoliants and desiccants. Fungicides, algaecides, bactericides, biocides and wood preservatives. Pesticides and environment, Toxicology and safe use of pesticides, insecticide act, Pesticide formulations, detrimental effect of pesticides on environment. Pesticide residues, management, methods to reduce residues at home and in agriculture. Biopesticides, Synthesis of triazinobenzimidazol, Coumarin derivatives, Antimicrobial agents, Environmentally benign methods for pest control. Reflection of a synthetic chemist. Essential oil based pesticides. New dimensions of food safety and food quality research. Pyrethroid pesticides- phenothrin, cyphenothrin, transfluthrin, permethrin and bifenthrin.

Chem. 591 Seminar

Chem. 600 Master's Research

Chem. 700 Ph.D. Research

ECONOMICS & SOCIOLOGY

A. ECONOMICS

PROGRAMMES

M.Sc. (Agricultural Economics)

Ph.D. (Agricultural Economics)

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Farm Management, Agricultural Marketing, Agricultural Finance
Required Courses	Econ.501, Econ.502, Econ.503, Econ. 506.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Statistics, Mathematics, Agri. Business Management, Business Management or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Farm Management, Agricultural Marketing, Agricultural Finance
Required Courses	Econ. 601, Econ. 602, Econ. 603.
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Statistics, Agri. Business Management, Business Management, Extension Education or any other as approved by the Dean Postgraduate, Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Econ. 51 Elementary Farm Management and Finance 2+1 Sem. II

Farm Management- meaning, scope, importance and relationship with other sciences, Farm management decisions. Characteristics of Punjab farms. Concept of package of practices and its application in terms of cost and returns. Simple planning and budgeting procedure. Farm records. Agricultural finance- nature and significance of agricultural finance. Credit institutions. Capital and credit needs. Classification of farm credit. Use of balance sheet and income statement in credit appraisal. Credit acquisition and repayment schedule.

Practical: Preparing farm maps, inventory and farm plan. Maintenance of farm records. Visits to regulated markets, ware houses, co-operative marketing societies and grading laboratories.

Econ. 52 Marketing of Farm Products 2+0 Sem. I

Marketing- Importance, concepts and definition. Market functions and services. Types of markets. Market functionaries. Method of sale. Market channels, charges and price spread. Market regulation. Market information. Concept and importance of grading and standardization of various food grains, vegetables, fruits and commercial crops at farm and market level. Criteria for formulation of grades. Grade standards adopted by different agencies. Agmarking of honey, flour, ghee, spices, etc. Sampling, analysis, and standard specifications. Role of various marketing agencies and State Government in grading of farm produce.

Econ. 102 Fundamentals of Agricultural Economics 2+0 Sem. II

Economics- meaning, scope and subject matter and approaches to economic analysis- micro and macro economics, positive and normative analysis, equilibrium analysis. Nature of economic theory- economic methods, laws of Economics, assumptions. Basic concepts- goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics- meaning, characteristics, importance and its role in agricultural planning and economic development of a country. Demand- meaning of demand and its determinants, law of demand, demand schedule and derivation of demand curve, utility analysis of demand, consumer's equilibrium and consumer surplus. Elasticity of demand concept and measurement of price, income and cross elasticity of demand. Production- nature and factors of production, input- output relationship and laws of returns. Cost- cost concepts, short-run and long-run cost curves. Supply- supply concepts, stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply. Market structure- meaning and types of markets, price determination under perfect and imperfect competition in short and long run of firm and industry, shut down and break even points. Distribution theory- meaning, factor market and pricing of factors of production, concepts of rent, wage, interest and profit. National income: meaning, importance, circular flow and accounting of national income, approaches and difficulties in its measurement. Population: population theories, determinants and population control measures. Money- barter system, money supply, general price index, inflation and deflation. Banking- role, types of banks and functions of commercial and central banks and credit creation policy of banking system. Agricultural and public finance- meaning, types and need of agricultural finance, public revenue and public expenditure. Tax- meaning, direct and indirect taxes, agricultural taxation, VAT, GST. Economic systems- concepts of economy and its functions, capitalistic, socialistic and mixed economies, elements of economic planning.

Econ. 201 Economics and Marketing 2+1 Sem. I

Economics terms and definitions- Consumption, Demand, Price and Supply. Factors of production. Gross Value Added. Role of Biotechnology/Agriculture sector in national GVA. Marketing- definition, process, need, role and functions. Classification of markets. Various

channels of farm produce. Price spread. Marketing efficiency. Constraints in marketing of agricultural produce. Market intelligence: Basic guidelines for preparation of project reports, Bank norms, Insurance, SWOT analysis and Crisis management.
Practical: Techno-economic parameters for preparation of projects. Preparation of bankable projects for various biotechnology/ agricultural products and value added products. Identification of marketing channel. Calculation of price spread. Identification of market structure. Visit to different regulated markets, market institutions. Study of SWC, CWC, STC and other processing agencies. Analysis of information of daily prices. Marketed and marketable surplus of different agricultural commodities.

Econ. 203 Introduction to Economics and Project Evaluation 2+0 Sem. I
Definition and scope of Economics and its relationship with ecology and biology sciences. Basic Economic concepts. Consumption: various types and theories, factors affecting consumption. Production: meaning, forms, production process, various factors of production. Costs: meaning, types, importance. Demand and Supply: meaning, relationship with price, various functions, factors affecting demand and supply. Principles of profit maximization. Market structure: monopoly, perfect competition. Development and environment, project formulation, analysis and evaluation.

Econ. 204 Agricultural Marketing, Trade and Prices 2+1 Sem. II
Agricultural marketing: concepts, definitions; market structure, marketing mix and market segmentation. Classification and characteristics of agricultural markets. Nature and determinants of demand and supply of farm products. Producer's surplus – meaning, types, marketable and marketed surplus and factors affecting marketable surplus of agri-commodities. Product life cycle (PLC) and competitive strategies. Pricing and promotion strategies and approaches. Market promotion – advertising, personal selling, sales promotion and publicity. Marketing process-concentration, dispersion and equalization; GST and its implications for agriculture, Marketing functions- exchange functions, physical functions and facilitating functions. Market functionaries- types and importance of agencies involved in agricultural marketing; Marketing channels- meaning, definition, number of channel levels and marketing channels for different farm products. Market integration- Meaning, definition and types; marketing efficiency; Marketing costs, margins and price spread-Factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions. Cooperative marketing in India. Risk in marketing-types, speculation & hedging and futures trading. Agricultural prices - meaning, functions and administered prices. Need for agricultural price policy; Trade: concept and need of International Trade, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO: Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.
Practical: Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies. Identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Analysis of principles of comparative advantage of international trade.

Econ. 205 Agricultural Finance and Co-operation 2+1 Sem. I
Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit-meaning, definition, need and classification. Credit analysis: 4 R's

and 3 C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro finance, KCC, Lead bank scheme and RRBs. Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent development in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports- Bank norms and SWOT analysis. Agricultural Cooperation – meaning, brief history of cooperative development in India, objectives, principles and significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.
Practical: Determination of most profitable level of capital use. Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business. Preparation and analysis of balance sheet and income statement. Appraisal of a loan proposal. Preparation of projects for agricultural and value added products.

Econ. 304 Farm Management, Production and Resource Economics 1+1 Sem. II
Farm management-meaning, concept and objectives. Farms-meaning, types, characteristics, factor determining types and size of farms. Principles of farm management- production function and its type, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Cost- meaning, concept, types and their interrelationship. Importance of cost in managing farm business and estimation of gross farm income, net farm income, family labor income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Farm records and accounts- importance, types , farm inventory, balance sheet, profit and loss accounts. Farm planning and budgeting- meaning, importance, partial and complete budgeting. Steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises. Risk and uncertainty in agriculture production- concept, nature, sources and its management strategies, Crop/livestock/machinery insurance – weather based crop insurance, features, determinants of compensation. Resource economics, externalities in agriculture. Inefficiency, welfare loss and solutions. Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.
Practical: Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in India.

Econ. 433 Micro Economic Analysis 3+1 Sem. I
Micro Economics: meaning, definition, importance, nature and scope. Theory of consumer behavior: marginal utility analysis and indifference curve analysis. Demand analysis: meaning, definition, derivation of demand curve. Firm and industry: meaning, types, difference between firm and industry, equilibrium conditions, short-run and long-run analysis. Production: meaning, process and factors of production, relationship between production and different factors,

production lags. Theory of producer behaviour: production function, costs, optimization of inputs use and product combinations, maximization of returns, specialization and diversification and supply analysis. Product market: meaning, types, assumptions, conditions of perfect and imperfect markets. Equilibrium of a firm and industry, determination of price and output of commodities under different market situations. Factor pricing: meaning, different theories for determination of rent, wages, interest and profit.
Practical: Practical training to study consumer behavior in relation to demand of various commodities, consumer survey. Economic analysis of a firm and industry. Working knowledge of relationship between production and different factors of production, production costs and optimum input use. Product market survey. Practical training of price determination in different types of markets.

Econ. 434 Macro Economic Analysis 3+0 Sem. I
Macro Economics: meaning, definition, importance, limitations, scope and integration of micro and macro analysis. Basic macro economic concepts. National income: meaning, definition, types, measurement and social accounting. Circular flow of money. Simple Keynesian model of income determination, shifts in aggregate demand. Multiplier. Theories of consumption and investment. Income determination model including money and interest. Monetary policy: meaning, instruments, indicators, lags and effectiveness. Fiscal policy: meaning, definition, different tools and limitations. Wage and employment policies: meaning, need, demand and supply of labour, measures of full employment, relationship between level of employment and output. Inflation and recession: process, causes, types and remedies. Introduction to Indian economy and comparison with other related economies. Significant economic problems in Indian agriculture relating to agricultural production and productivity, credit, marketing, labour and environment.

Econ. 491 Agro- industrial Attachment 0+4 Sem. I

Postgraduate Courses

Econ. 501/Mgt. 503/ABM 503 Micro Economics/Managerial Economics 3+0 Sem. I
Theory of consumer behavior: cardinal utility approach, ordinal utility approach, applications of indifference curve approach, revealed preference hypothesis. Demand theory, elasticity of demand. Consumer's surplus. Theory of the firm. Theory of production : production functions, returns to scale and economies of scale. Theory of costs : cost curves, profit maximization and cost minimization. Law of supply, producers' surplus. Price determination under various market situations: perfect competition, monopoly, monopolistic competition, oligopoly. Theories of distribution. General equilibrium theory. Welfare Economics.

Econ. 502 Macro Economics and Policy 3+0 Sem. I
Nature and scope of Macro Economics. National income : concepts and measurement. Classical theory of employment and Say's Law. Modern theory of employment and effective demand. Consumption function. Investment and savings. Concept of multiplier and accelerator. Output and employment. Rate of interest : classical, neo-classical and Keynesian version, classical theory V/s Keynesian theory. Unemployment and full employment. Money : classical theories of money and price, Keynesian theory of money. Supply of money. Demand for money. Inflation- nature, effects and control. IS & LM frame work : General equilibrium of product and money markets. Monetary policy. Fiscal policy. Effectiveness of monetary and fiscal policy. Central banking. Business cycles. Balance of payment. Foreign exchange rate determination.

Econ. 503 /Mgt. 527 Econometrics 2+1 Sem. II
Introduction: relationship between economic theory, mathematical economics, models and

econometrics. Methodology of econometrics. Representation of economic phenomenon, relationship among economic variables, linear and non-linear economic models. Analysis of economic time-series components and their interpretation. Ordinary least squares methods of estimation of simple and multiple regression models. The BLUE properties of least squares estimate, tests of significance and confidence intervals. Indirect least square method of estimation. Maximum likelihood estimation. Problems of multicollinearity, heteroscedasticity and auto-correlation. Principal component analysis, use of dummy variables. Generalized Aitkin's least squares methods of estimation. Distributed lag models. Estimation from grouped data. Application of computer software for solving practical econometric problems. Simultaneous equation models - structural equations, reduced form equations, identification and approaches to estimation.

Practical: Practicals on single equation two variable model specification and estimation, hypothesis testing, transformations of functional forms and OLS application. Estimation of multiple regression models: hypothesis testing, testing and correcting specification errors, testing and managing multicollinearity, heteroscedasticity, autocorrelation. Estimation of regressions with dummy variables, estimation of regression with limited dependent variable. Identification of equations in simultaneous equation systems.

Econ. 504 Agricultural Production Economics 2+1 Sem. I

Nature, scope and significance of agricultural production economics. Agricultural production processes. Production functions, assumptions, commonly used forms, properties, limitations, specification, estimation and interpretations. Factors of production, classification, interdependence, and factor substitution. Determination of optimal levels of production and factor application : optimal factor combination and least cost combination of production. Theory of product choice: selection of optimal product combination. Cost functions and cost curves, components, and cost minimization. Duality theory : cost and production functions and its applications. Derivation of firm's input demand and output supply functions. Economies and diseconomies of scale. Technology in agricultural production, nature, effects and measurement. Measuring efficiency in agricultural production: technical, allocative and economic efficiencies. Yield gap analysis, concepts-types and measurement. Nature and sources of risk, modelling and coping strategies.

Practical: Different forms of production functions : specification, estimation and interpretation of production functions, returns to scale, factor shares, elasticity of production, physical optima, economic optima, least cost combination, optimal product choice, cost function estimation, interpretation, estimation of yield gap, incorporation of technology in production functions, measuring returns to scale, risk analysis through linear programming.

Econ. 505 Agricultural Marketing and Price Analysis 2+1 Sem. I

Market structure, conduct and performance analysis. Problems in agricultural marketing from demand, supply and institutions sides. Market intermediaries and regulation. Marketable and marketed surplus estimation. Marketing efficiency. Vertical and horizontal integration. Marketing co-operatives - APMC, direct marketing, contract farming and retailing. Supply chain management. State trading: Warehousing and other government agencies. Performance and strategies: market infrastructure needs, performance and government role. Value chain finance. Role of information technology and telecommunication in marketing of agricultural commodities. Market research, market information service, electronic auctions (e-bay), e-chaupals, Agmarket and Domestic and Export Market Intelligence Cell (DEMIC). Market extension. Spatial and temporal price relationship : price forecasting, time-series analysis, time-series models, spectral analysis. Price policy and economic development. Non-price instruments. Theory of storage: introduction to commodity markets and future trading, basics of commodity futures, operation mechanism of commodity markets, price discovery, hedging and basis, fundamental analysis, technical analysis. Role of government in promoting commodity trading and regulatory measures.

Practical: Practical training of supply and demand elasticities, price spread, price forecasting, concentration ratios and marketing efficiency analysis. Marketing structure analysis of regulated market and marketing societies. Analysis on contract farming and supply chain management. Chain analysis : quantitative estimation of supply chain efficiency. Online searches for market information sources and interpretation of market intelligence reports. Technical and fundamental analysis for important agricultural commodities, presentation of the survey results and wrap-up discussion.

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

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

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

Econ. 507 Evolution of Economic Thought **2+0** **Sem. I**

History of economic thought: Absolutist V/s Relativist approaches. Evolution of economic thought V/s economic history. Ancient economic thought : medieval, mercantilism, physiocracy. Forerunners of classical political economy. Development of classical thoughts (Adam Smith, Robert Malthus and David Ricardo). Critics of classical thoughts: socialist critics. Socialist and Marxian economic ideas. Austrian School of thought. Origins of formal microeconomic analysis : William Stanley Jevons, Cournot and Dupuit. The birth of neoclassical economic thought: Marshall and Walras. General equilibrium theory. Welfare theory : Keynesian economics. The era of globalization : experiences of developing world. Rigidity of the past V/s emerging realism. The changing path of international institutions to economic growth and development approaches. Economic thought in India: Naoroji and Gokhale. Gandhian Economics. Economic thought of independent India. Nehru's economic philosophy. Experiences of the structural adjustment programmes of the post liberalization era.

Econ. 508/ Mgt. 512/ABM 512/ Stat. 527 Quantitative and Optimization Techniques for Economics and Management **2+1** **Sem. II**

Role of quantitative methods in decision making, probability and decision making under risk and uncertainty, value of additional information, Bayes theorem, probability models and decision making. Sample survey, measurement and forecasting, index numbers, time-series, optimization models. Linear programming: Formulation of simplex method, primal and dual, sensitivity analysis. Transportation and assignment models, dynamic programming, network analysis, PERT and CPM. Game theory: concept, two person constant sums, zero-sum games, saddle point, solution to mixed strategies. Markov chain analysis, queuing models: waiting line problem, characteristics of waiting lines, single channel model, multiple channel model, constant service time model, finite population model, sequencing and replacement models. Simulation and Monte Carlo methods.

Practical: Graphical and algebraic formation of linear programming models. Solving of

maximization and minimization problems by simplex method. Formulation of the simplex method by typical farm situations. Solution of other numerical problems, case studies and discussion.

Econ. 509 Agricultural Finance and Project Management 2+1 Sem. II

Role and importance of agricultural finance. Financial institutions and credit flow to rural/priority sector. Agricultural lending : direct and indirect financing, financing through co-operatives, NABARD and commercial banks and RRBs. District credit plan and lending to agriculture/priority sector. Micro- financing and role of MFI's -NGO's, and SHG's. Lending to farmers : concept of 3 C's, 7 P's and 3 R's of credit. Estimation of technical feasibility, economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Financial decisions : investment, financing, liquidity and solvency. Financial statements : balance sheet, cash flow statement and profit and loss account. Ratio analysis. Project approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project appraisal techniques : undiscounted measures. Time value of money. Use of discounted measures : B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Network techniques - PERT and CPM. Risks in financing agriculture. Risk management strategies and coping mechanism.

Practical: Estimation of demand and supply gaps of institutional agricultural credit. Preparation of farm credit plan and financial statements using farm/firm level data. Farm credit appraisal techniques and farm financial analysis through financial statements. Performance of micro financing institutions : NGO's and Self-Help Groups. Identification and formulation of agricultural investment projects. Practical training of project appraisal techniques: undiscounted and discounted measures along with their limitations. Case study analysis of an agricultural project, financial risk and risk management strategies.

Econ. 510 International Economics 2+1 Sem. I

Scope and significance of international economics. The role of trade. General equilibrium in a closed economy. Equilibrium in a simple open economy. Possibility of world trade. Trade gains and trade equilibrium. Tariff, producer subsidy, export subsidy, import quota and export voluntary restraints: The case of small and large countries. Ricardian model of trade, specific factors model, Heckscher-Ohlin Model. Trade creation and trade diversion, offer curve. Export supply elasticity and import demand elasticity. Comparative advantage and absolute advantage. Official exchange rate and shadow exchange rate. Walras Law and terms of trade. Trade blocks. IMF, World Bank, IDA, IFC, ADB. International trade agreements :Uruguay Round, GATT, WTO. Recent developments in the international agricultural trade policies and implications for developing countries.

Practical: Producer's surplus, consumer's surplus, national welfare under Autarky and free trade equilibrium with small and large country assumption. Estimation of trade gains. Estimation of competitive and comparative measures like NPC, EPC, ERP and DRC. Estimation of offer curve elasticity. Estimation of effect of tariff, export subsidy, producer subsidy, import quota and export voluntary restraints on national welfare. Estimation of Ricardian model. Estimation of effect of trade under specific factor model. Estimation of trade equilibrium under Heckscher - Ohlin model. Trade creation and diversion.

Econ. 511 Agricultural Development and Policies 3+0 Sem. II

Development economics : scope and importance. Economic development and economic growth. Indicators and measurement of economic development : GNP as a measure of economic growth. New measures of welfare : NEW and MEW, PQLI, HDI, Green GNP criteria for under development. Obstacles to economic development. Economic and non-economic factors of economic growth. Economic development : meaning, stages of economic

development, determinants of economic growth. Theories of economic growth. Optimal economic growth : recent experiences of developing economies in transition. Role of state in economic development. Development planning. Role of agriculture in economic/ rural development. Agriculture and food supply, resource policies, credit policies, input and product marketing policies, price policies. Development issues, poverty, inequality, unemployment and environmental degradation. Models of agricultural development : induced innovation model. Policy options for sustainable agricultural development. Globalization and agricultural development. The dilemma of free trade: free trade versus protectionism. Role of protection in developing countries. WTO : Agreement on Agriculture.

Econ. 512 Institutional Economics 1+0 Sem. I

Old and new institutional economics. Institutional economics V/s neo-classical economics. Definition of institutions. Distinction between institutions and organizations. Institutional evolution. Institutional change and economic performance. National and international economic institutions. Transaction cost economics : transaction costs and the allocation of resources. Transaction costs and efficiency. Asymmetric information : moral hazard and principal-agent problem. Free rider problem : path dependency. Interlinked transactions. Collective action and the elimination of free-rider problem. Theory of Groups. Rent seeking : interest groups and policy formulation. Special features of institutional arrangements in agriculture. Theories of agrarian institutions, tenancy institutions.

Econ. 513 Natural Resource and Environmental Economics 3+0 Sem. II

Concepts, classification and problems of natural resource economics. Economy and environment interaction: Material balance principle, Entropy law, resources scarcity. Limits to growth : measuring and mitigating natural resource scarcity, Malthusian and Ricardian scarcity, scarcity indices, resource scarcity and technical change. Theory of optimal extraction renewable resources. Hotelling's rule, Solow-Harwick's Rule. Theory of optimal extraction exhaustible resources : economic models of forestry and fishery. Efficiency and markets : market failures, externalities, types. Property rights : transaction costs, Coase's theorem and its critique. Public goods : common property and open access resource management. Collective action. Environmental perspectives : biocentrism, sustainability, anthropocentrism. Sources and types of pollution : air, water, solid waste, land degradation, environmental and economic impacts, Economics of pollution control. Environmental regulation : economic instruments, pollution charges, Pigovian tax, tradable permits, indirect instruments, environmental legislations in India. Concept of sustainable development. Indicators of sustainability. Relation between development and environment stress. Environmental Kuznet's curve. Environmental accounting : resource accounting methods. International environmental issues, climate change, likely impacts mitigation efforts and international treaties.

Econ. 514 Rural Marketing 2+0 Sem. II

Concept and scope of rural marketing: nature, characteristics and potential. Environmental factors : socio- cultural, economic and other environmental factors affecting rural marketing. Rural consumer's behaviour : behaviour of rural consumers and farmers, buyer characteristics and buying behaviour. Rural v/s urban markets. Rural marketing strategy : marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning, product mix, pricing course objective, pricing policy and pricing strategy. Input marketing in the rural areas. Inter linkage of rural marketing with credit. Product promotion : media planning, planning of distribution channels, and organizing personal selling in rural market in India.

Econ. 515 Commodity Futures Trading 2+0 Sem. I

History and evolution of commodity markets. Terms and concepts: spot, forward and futures markets, factors influencing spot and future markets. Speculatory mechanism in commodity

futures. Transaction and settlement. Delivery mechanism: role of different agents, trading strategies, potential impact of interest rate. Foreign Exchange. Risk in commodity trading, importance and need for risk management measures. Important global and Indian commodity exchanges : contracts traded, special features. Regulation of Indian commodity exchanges. Forward market commission and its role. Market indicators: back testing.

Econ. 516 Farm Management Economics 2+1 Sem. II

Meaning and functions, development of farm management as a science, management factor in commercial agriculture. Organization and operation of the farm business for optimal resource use. Cost and returns concepts. Relationship between different farm enterprises. Farm adjustment programmes under uncertain conditions. Farm records and accounting. Efficiency measures for different types of enterprises and farm business.

Practical: Preparation of layout maps, maintenance of farm business records, summarization and analysis of the accounts and preparation of enterprise, labour and partial budgets, alternative plans and control charts in respect of the assigned farm.

Econ. 517 Money and Banking 2+0 Sem. I

Evolution of money. Nature and functions of money with special reference to the macro economic variables, various forms of money, changes in the value of money, monetary standards, role of commercial banks and other banking institutions. Principles and procedure of lending, documentation etc. Instruments of credit, structure and functions of a central bank in the context of economic planning, international monetary relations and institutional set up.

Econ. 518 Agribusiness Environment and Policy 2+0 Sem. I

Role of agriculture in Indian economy; problems and policy changes relating to farm supplies, farm production, agro-processing, agricultural marketing, agricultural finance. Structure of agriculture : linkages among sub-sectors of the agribusiness sector, economic reforms and Indian agriculture. Impact of liberalization, privatization and globalization on agribusiness sector. Emerging trends in production, processing, marketing and exports. Policy controls and regulations relating to the industrial sector with specific reference to agro-industries. Agribusiness policies: concept and formulation, and new dimensions in agri-business environment and policy. Agricultural price and marketing policies, public distribution system and other policies.

Econ. 519 Management of Agribusiness Cooperatives 3+0 Sem. II

History of co-operatives in India. Principles of co-operation. Cooperative administration: a global perspective, cooperative sector and economic development. Cooperative management: nature, functions and purpose of cooperatives, procurement, storage, processing, marketing, process of cooperative formation, role of leadership in cooperative management. The state and cooperative movement, effects of cooperative law in management, long range planning for cooperative expansion, policy making. Human resource management, placement and role of board of directors in cooperative management. Overview of agribusiness cooperative : credit cooperatives, cooperative marketing, dairy cooperative, financing agribusiness cooperative.

Econ. 520/Forst. 506 Forest Resource Management and Economics 1+1 Sem. I

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

Practical: Exercises on estimation of demand and supply functions, biodiversity valuation,

valuation of non- marketed forest products. Exercises on financial and economic appraisal of forestry projects. Exercises on marketing of forest products and international trade competitiveness. Computer applications for using programming techniques in evaluating forest management alternatives.

Econ. 601 Advanced Micro Economic Analysis 2+0 Sem. II

Modern micro economic theories with focus on risk and uncertainty. Perfect competition, monopoly, monopolistic competition and oligopoly. Theory of imperfect competition. Introduction to general equilibrium theory: conceptual overview, general equilibrium conditions with production and consumption. Walrasian general equilibrium: mathematical derivation of conditions for general equilibrium. Welfare Economics : concepts, problems, approaches and limitations of welfare economics, Pareto conditions of maximum welfare. Criteria for social welfare. Social welfare functions, social V/s private costs and benefits.

Econ. 602 Advanced Macro Economics Analysis 2+0 Sem. II

Review of macro economics concepts. National income and national product. Static and dynamic analysis. Consumption function and theories of consumption. Saving and investment function. Savings and investment equality : IS - LM framework. Equilibrium in dynamic system. Classical, Keynesian and post-Keynesian theories of output and employment. Demand for and supply of money. Theory of money and prices. Monetary equilibrium. Central Bank's monetary policy, the problems of planning and flexibility. Inflation. Stagflation and supply side economics. Business cycle theories, monetary and fiscal framework for economic stability and growth. Structural adjustment mechanisms. Impact of WTO on Indian economy, Impact of IMF & IBRD on Indian economy. Review of macroeconomic policies in India.

Econ. 603 Advanced Econometrics 2+1 Sem. II

Review of classical regression model : review of hypothesis testing, restrictions on parameters, single equation techniques. Multivariate analysis. Simultaneous equation system. Various estimation methods for interdependent equation systems : maximum likelihood, weighted regression, grouping of observations. Identification problems, identifiability conditions. Dynamic models, impact multipliers and dynamic discrepancies. Handling of these problems in empirical context.

Practical: Estimation of multiple regression model : GLS estimation methods, testing mis-specification errors. Testing and managing multicollinearity, heteroscedasticity and autocorrelation. Estimation of LPM, Logit and Probit models comparing two regressions. Chow test, estimation of distributed lag models, panel data random and fixed effects models. Indirect least squares 2SLS, SURE, 3SLS, estimation of simultaneous equation models.

Econ. 604 Advanced Production Economics 2+1 Sem. II

Agricultural production process. Production functions, components, assumptions, properties and their economic interpretation. Production relations. Linear, Spillman -Cobb Douglas, quadratic, multiplicative (power) functional forms, Translog, and transcendental functional forms, CES, production functional forms. Conceptual and empirical issues in specification, estimation and application of production functions. Economic optimum : determination of economic optimum with constant and varying input and output prices. Cost curves. Principles and importance of duality theory. Correspondence of production, cost, and profit functions. Principles and derivation of demand and supply functions. Technology, input use and factor shares, effect of technology on input use-decomposition analysis-factor shares-estimation methods. Economic efficiency in agricultural production. Yield gaps analysis. Risk and uncertainty in agriculture Simulation and programming techniques in agricultural production. Multiple Course Objective Programming: goal programming and compromise programming and applications.

Practical: Estimation of different forms of production functions. Optimal input and product choice

from estimated functions. Derivation of demand and supply functions. Estimation of cost functions. Decomposition analysis. Estimation of efficiency measures: stochastic, probabilistic and deterministic frontier production functions. Risk programming: MOTAD, quadratic programming. Simulation models for agricultural production decisions.

Econ. 605 Quantitative Development Policy Analysis 2+1 Sem. I

Policy framework: goals, values, beliefs and welfare maximization. Market: policy and state, state V/s market, failure of policy, failure of markets, rationale for government intervention. Role of quantitative policy analysis. Demand analysis for policy making: alternative approaches to demand analysis, policy implications. Supply response: alternative approaches to measurement of supply response, Nerlovian models of supply response, policy implications. Household behaviour and policy analysis. Household models. Partial equilibrium analysis: concept of reference prices, price distortions, indicators and impact. Transaction costs: implications for efficiency and productivity. Institutional solutions: multimarket approach to policy analysis. Social accounting matrices and multipliers. Computable General Equilibrium Models to assess economy wide impact of policy changes.

Practical: Review of criteria for policy evaluation. Estimation of price elasticities. Review of estimation of complete demand systems. Estimation of Nerlovian supply response model. Review of household models, specification and estimation of household models. Partial equilibrium analysis. Input-output table. Social accounting matrix: construction of a SAM. Computation of multipliers. Multi market analysis. Review of computable general equilibrium models.

Econ. 606 Advanced Agricultural Marketing and Price Analysis 2+1 Sem. I

Importance of market analysis in the agricultural system. Types of marketing: advantages and disadvantages. Quantitative estimation : the distinguishing characteristics and role of agricultural prices, data sources for agricultural products and prices. Softwares used in market analysis. Role of various formal institutions in agricultural marketing functions and their efficiency. Public- private partnership. Successful case studies. Multimarket estimation, supply response models. Market integration and price transmission: supply/value chain management. GAP analysis. Current trends in information in the changing agrifood system. Agricultural commodity marketing: spot and futures. Marketing derivatives: speculation, hedging, swap, arbitrage. Commodity exchanges: price discovery and risk management. Markets regulatory mechanism of futures trading. Lag operators and difference equations: stationary and stochastic processes, unit roots and co- integration, conditional heteroscedasticity, ARCH and GARCH models. Forecast evaluation: methods of forecasting. Price indices and econometric estimation and simulation.

Practical: Estimation of demand/ supply forecasting, supply chain / value chain analysis for different commodities. Commodity models: multimarket estimation, time-series analysis. Market integration studies: price discovery, price volatility estimation. Commodity price forecasting using econometric softwares.

Econ. 607 Advances in Commodity Futures Trading 2+0 Sem. II

Historical perspective of development of commodity markets. Various terms and concepts used in commodity marketing: spot, forward and futures markets, factors influencing spot and future markets. Advanced speculatory mechanism in commodity futures. Transaction and settlement: delivery mechanism, role of different agents at national and international level, trading strategies, potential impact of interest rate. Foreign exchange, FDI in commodity markets. Risk in commodity trading, importance and need for risk management measures: managing market price risk, hedging, speculation, arbitrage, swaps pricing and their features. Important global and Indian commodity exchanges, contracts traded, special features. Regulation of Indian commodity exchanges, FMC and its role. Fundamental V/s technical analysis: construction and interpretation of charts and chart patterns for analysing the market trend. Market indicators-

back testing. Introduction to technical analysis software - analysing trading pattern of different commodity groups.

Econ. 608 Advanced Environmental Economics 2+0 Sem. I
Environmental pollution as a consequence of market failure. Causes and consequences of market failure. Externalities: public goods and externalities. Economics of pollution: private V/s social cost of environmental pollution. Property rights, environment and development. Theory of environmental policy. Environmental cost-benefit analysis. Environmental impact assessment techniques: non-market valuation of environmental resources (WTP/WTA). Environment, market and social welfare. Economic growth and environmental cost. Growth oriented economic policies and their environmental impacts. Population and environmental quality: poverty and environmental degradation. Green taxes. Political economy of environmental regulation and management. Transboundary environmental problems. Economics of global warming, climate change and emission trading. Environment, international trade and development.

Econ. 609 Advanced Agricultural Economics 3+0 Sem. I
History of agricultural development. Theories of agricultural development. Agriculture in different countries with different social, political and economic systems. Institutional setting in agriculture, inter- sectoral forward and backward linkages. Agricultural development process under various economic systems. Distributional justice, distortions by political and economic factors, impact of agricultural development on investment, capital formation and employment, agricultural taxation, World trade in agriculture and external competitiveness. Review of agriculture policy and impact and institutional changes in agricultural development.

Econ. 610 Advanced Agricultural Financial Management 2+0 Sem. I
Nature, significance and basic principles of agricultural finance, influence of time on costs and returns. Farm financial management, acquiring farm capital, financial analysis of the farm business balance sheet: income statement and cash flow statement. Financial markets. Financial intermediaries serving agriculture. Impact of monetary and fiscal policy of farm finance. Examination of alternative systems with a view to identify feasible modifications and improvement.

Econ. 591 Seminar

Econ. 600 Master's Research

Econ. 700 Ph.D. Research

B. SOCIOLOGY PROGRAMMES

M.Sc.

Ph.D.

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Rural Sociology, Social Change
Required Courses	Soc. 501, Soc. 502, Soc. 503, Soc.506.
Supporting Courses	Stat. 421, PGS 501 and other courses from the subject matter fields other than minor) relating to area of special interest and research problem.
Minor Fields	Agri. Business Management, Economics, Extension Education, Human Development, Statistics or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Rural Sociology, Social Change
Required Courses	Soc. 601, Soc. 602
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and Research problem.
Minor Fields	Economics, Extension Education, Business Management, Human Development, Statistics or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

Soc. 101 Rural Sociology and Educational Psychology 2+0 Sem. I

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology, Rural society, Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development. Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

Soc. 102 Introduction to Rural Sociology 2+0 Sem. II

Rural sociology- meaning, scope and significance. Structural differentiation in terms of difference and characteristics of rural and urban societies. Planned social change-approaches to rural planning, improvement and transformation and their shortcomings. Indian rural development programs (IRDPs). Indian rural social stratification. Caste- basic notions, changes and its role in economy and policy. Difference between caste and class. Backward classes and implementations of constitutional provisions. Indian rural social institutions- family and marriage (Nature, forms and changes). Economic-political- land relations and changes, rural poverty its manifestations and causes. Religious- functional significance of beliefs, traditions and customs. Rural social changes- processes and factors of transformation. Status of women in rural India and their role in rural and agricultural development.

Soc. 421 Applied Rural Sociology 3+0 Sem. II

Rural sociology as a science. Basic concepts. Physical and social structure of rural society. Organization and groups. Social stratification. Value system. Social change. Leadership pattern. Diffusion and adoption of farm technology.

Soc. 422 Rural Community Organization 2+0 Sem. II

Structure and functions of rural community. Organizational and informal relationships. Process of making decisions and policy for community development through agricultural extension, school systems and other agencies. Handling a group project for the analysis of social structure. Formal and informal relationships. Decision making channels and authorities for suggesting an outline of the community action programme in a given problem area.

Soc. 423 Society and Culture 2+0 Sem. II

The meaning of society and culture, its significance for human being and its diverse forms. Interaction and its processes of growth. Social relations and organizations among selected people around the world including kinship, religious, fraternal, occupational and political forms of behaviour. Effects of environment on human behaviour.

Soc. 424 Technology and Social Change 2+0 Sem. I

Concepts of social change. Development and economic growth. Determinants of social change. Concepts of structural changes: social, cultural, economic, political and technological change. Change associated with development. Technological breakthrough and social change. Consequences of social change.

Soc. 425 Population and Society 2+0 Sem. I

The mutual influences of demographic factors and social structure. Fertility and mortality. Micro and macro dynamics of population. Population policy and economic development. Population explosion and its impact on society.

Postgraduate Courses

Soc. 501 Rural Society **3+0** **Sem. I**

Fundamentals: origin, nature, scope and importance of rural sociology. Concepts and recent approaches used in the study of rural society and application of scientific method. Agrarian social structure, salient features of rural society: Rural-urban differences, caste structure in rural set up, intercaste relations, Jajmani system, caste and politics. Rural economy. Rural family: their types and characteristics in different regions of India. Role of religion in rural life. Peasant culture and dynamics of technology affecting agriculture. Landless agricultural labourers, their role and problems. Diffusion of innovations: elements of adoptions, stages in the adoption of innovation, adopter categories and their characteristics. Village cooperative societies. Peasant unrest and agrarian movements. Rural development programmes. Rural social problems.

Soc. 502 Society and Change **3+0** **Sem. I**

Meaning and definition of social change. Concepts of social evolution, revolution, diffusion, development, progress and growth. Cultural change, Lag-hypothesis. Theories of social change: Cyclical theories, Ancient theory, Oswald Spengler, Pitrim Sorokin, A.J. Toynbee, Vilfredo Pareto. Liner/evolutionary theories: Karl Marx, Thorstein Veblen. Factors of social change: demographic, economic, technological, legislative, physical, mass media. Processes of Social Change: sanskritization and de-sanskritization, westernization, secularization, industrialization, urbanization, globalization, modernization. Depeasantization: extent, causes and consequences. Planned changed programme: objectives, achievements and impact. Problem of human adjustment in changing culture and society. Agricultural development and changes in various social institutions. Social problems: communalism, factionalism, crime, juvenile delinquency, drug abuse, terrorism, etc.

Soc. 503 Sociological Theories **2+0** **Sem. I**

Theoretical thinking in sociology. Major sociological theories. Evolutionary theories: Auguste Comte and Herbert Spencer on society, humans and change, class, gender and race. Functionalism: Emile Durkheim, Levi-Strauss, Bronislaw Malinowskhi on functionalism and organicism. Talcott Parsons' systems of action, action schema, pattern variables, functional system problem and social change. Robert K Merton: middle range theory, functional analysis and deviance. Conflict theory: Karl Marx and the origins of conflict and critical theory. Conflict theory of Ralf Dahrendorf. The conflict functionalism of Lewis A. Coser. Symbolic Interactionism. George Herbert Mead's the self, self interaction and symbolic meaning. Herbert Blumers interpretation and methodology. Phenomenology and Ethno methodology. Harold Garfinkel. Peter Berger: the social construction of reality. Modernization and post modernization.

Soc. 504 Evolution of Social Thought **2+0** **Sem. II**

Definition and characteristics of social thought. Evolution of social thought. Social thinkers. French: Auguste Comte, law of three stages, concept of positivism, social control, social status and social dynamics. Emile Durkheim methodology, social fact, social solidarity, division of labour, suicide, and religion. German: Max Weber, social action, social understanding, religion, capitalism, social class and Bureaucracy. Ferdinand Tonnies: social entities and social norms. Karl Marx: dialectical materialism, class struggle, surplus value, social change. English: Herbert Spencer; evolution theory, state activity and natural rights. Vilfredo Pareto; methodology, theory of residue, derivation, circulation of elites. American: Thorstein Veblen, theory of instinct, conspicuous surplus, social change, Talcott Parsons: social action, social control and

social system. Pitrim A. Sorokin; geographical factors, socio-cultural dynamics, individual personality, power and morality. C.H. Cooley: groups and communication. A. Giddens: modernity and structuration. Mahatma Gandhi: state and society, religion and God, satyagraha, ahimsa and swaraj. D.P.Mukerji: tradition and modernity. B.R.Ambedkar: caste system and Indian bureaucracy.

Soc. 505 Women Development Studies 3+0 Sem. I

Women in historical perspective. Past and present status of women. Health and nutritional status and health problems, reproductive, mortality and morbidity of women in different socio-economic categories. Public health facilities and their role. Gender and regional differences in literacy rate, dropouts and higher education, their implications on family and in society. Employment of women in agriculture and non-agriculture sectors: their extent of participation, and its impact on socio- economic status. Women specific problems: crimes against women, domestic violence, menace of dowry, female foeticide, girl child labour, sexual harassment at work place, their causes, consequences and remedies. Honour killings: causes and remedial measures. State and central sponsored women welfare programmes. Legislative measures and women empowerment: actions and achievements.

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

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

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

Soc. 507 Social Stratification 3+0 Sem. I

Social stratification: definition and the key concepts, basis characteristics of social stratification, historical and contemporary perspective. Generation of social stratification, differentiation, ranking, assessment and rewarding. Basic elements and processes of stratification: concept, measurements and problems of property, power and prestige. Theories of social stratification: functionalist perspective by Talcott Parsons and Robert K Merton. Conflict perspectives of social stratification: Karl Marx, Ralf Dahrendorf, Lewis Coser. Social stratification in Indian context: objective and subjective perspective. The ideology of purity and brahmanical view of caste. The emergence of class, Marxian method of class analysis and Weber's class, status and party. Gender: concept, measurement and implications in Indian context. Social mobility: concept, measurement and analysis. Social mobility and conflict. Socio-economic inequality. Implications of social stratification for Indian society.

Soc. 508 Rural Leadership 2+0 Sem. II

Meaning and definition of leader and leadership. Concepts of authority, dominance, influence, social power. Social interaction and human groups. Theories of social interaction-interaction as exchange (George Homan),symbolic interactionism (George Herbert Mead), impression management (Erving Goffman), psycho analytical (Sigmund Freud). Types of leaders in community life. Theories of Leadership: trait, interaction, situational and functional. Techniques of identifying leaders. Leader followers' relationship. Social values and leadership. Leadership and their role in community organization and changes. Panchayati raj system and peoples' empowerment. Emerging rural leadership patterns. Globalization and rural political structure.

Soc. 509 Human Ecology and Dynamics of Population 3+0 Sem. II

Meaning and definition of human ecology. Research techniques of qualitative and quantitative aspects of demography. Spatial distribution of population: village, city and region. Population Growth and distribution in India: growth of Indian population since 1901. Determinants of population growth: fertility, mortality, morbidity. Migration: meaning, measurement, causes and consequences. Climate change: causes and consequences. Population growth and sustainable development: future scenario. Theories of population growth: Malthusian and neo-Malthusian contribution to population and societal development, relevance of Malthus in contemporary developing societies. Diet theory by Thomas Doubleday. Population and development: population as a constraint on and resource for development. Population control: problems and perspectives, population policy. Ecological degradation and environmental pollution.

Soc. 510 Development and Quality of life 2+0 Sem. I

Conceptual perspective on development: economic growth, economic development, social development. Theories of development: dualistic theories, W.W.Rostow's, John Meynard Keynes and Karl Marx's theory of economic development. J.A. Schumpeter's theory of innovation. Sustainable development. Ecological, economic and social indicators of development: economic and social characteristics of underdeveloped. Paths of development with special reference to India. Modernization: meaning and aspects of modernity. Viewpoint of classical and contemporary theorists. Post modern social theory by Michel Foucault. Post modernity : the Indian experience. Concept of quality of life, measurement of quality of life, human development index. Comparative studies of quality of life in developed and developing countries. Globalization and quality of life. Scientific socialization and quality of life. Impact of development on quality of life.

Soc. 601 Sociology of Development 3+0 Sem. II

Meaning, nature and scope of sociology of development. Sociological and psychological aspects of economic growth. Significance of culture in the process of development. Evaluation of modernization theories. Development and underdevelopment- Indian case. Evaluation and development of various institutions of simple and advanced societies. .Social stratification and organizing principles of social life. Development efforts and their social, economic and environmental implications in post independence era. Global exposure and its effects on traditional social set up. Emergence of new institutions and their inter- relations.

Soc. 602 Recent Advances in Rural Sociology 3+0 Sem. II

Critical evaluation of the recent works of rural sociology. Contribution of sociology, anthropology, economics and psychology to the understanding of structure and functions of rural society. Change in development perspective, planning and social action and rural social policy, social values and developmental change, social spatial and economic limits of social change, socio-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 marginalized sections. Evaluation of various programmes of rural development. Agricultural development and the farmers of the world: experience of developed and developing nations. Emerging social trends and their consequences in rural India. Land tenure and agrarian relations. Social structure and agrarian relations. Peasant unrest-causes and consequences. Role of migrant labour in agriculture. Rural indebtedness, farmer's suicides.

Soc. 603 Contemporary Rural Social Problems 3+0 Sem. I

Concepts of organization and dis-organization in society. Social problems, types and their dimensions in role status. Level of social organization and social problems. Methods of studying social problems. Unemployment: magnitude, present features, measures taken. Population explosion: causes, effect and population policy. Scheduled castes, scheduled tribes and other backward castes. Youth unrest and agitations, child abuse and child labour. Violence against women. Illiteracy, crimes and criminals. Drug abuse and drug addiction. Problems of abundance and poverty, family and household. Communalism and secularism. Intellectual, ethical and social implications of social problems. The changing rural society.

Soc. 604 Demographic Analysis 3+0 Sem. I

Inter-relations of population dynamics and social change. Problems of data collection and measurement in planning for social development. Sources of demographic data: census method, sampling method and registration method. Techniques of population analysis. Fertility, reproduction, mortality, fecundity, migration, age and sex-specific distribution of population, density of population, dependency ratio, sex ratio, age at marriage and life expectancy. Village and urban community: Growth and features of village and city communities. Urban rural contrast, The Nation: growth and features. Social determinants of fertility, mortality and rate of change. Causes of population change and consequences. Population projections.

Soc. 605 Studies of Marginalized Sections 2+0 Sem. II

Historical, conceptual and theoretical perspectives of marginalized and subaltern sections of society. Forms of deprivation. Scheduled castes, scheduled tribes and other backward classes: definition and distribution. Past and present status. Prohibitions and atrocities against scheduled castes, backward castes and women.. Phenomenon of untouchability. Dalit's unrest and crisis of identity in India. Reservation policy. New trends in reservation and its implication in society. Women: gender inequality and disabilities: past and present changing status of women. Role of social reform movement, institutions, and individuals in welfare and development of deprived sections.

Soc. 606 Environment and Social Organization 2+0 Sem. II

Meaning and significance of environment for human existence. Dialectical relationship between environment and social organization. Environmental degradation: causes and implications. Forms of environmental pollution; air, water, agriculture, noise and radiation, and industrial wastes. Issue of climate change: causes and consequences. Agricultural environment in traditional and modern societies. Conditioning effects of environment on social organization. Environment and sustainable development. Environmental movements and their role. Environmental ethics. Legislative measures to check environmental degradation.

Soc. 607 Peasants Movements and Indian Agrarian Structure 2+0 Sem. II

Conceptual and historical perspectives of peasantry in India. Importance of peasantry in Indian society. Agrarian structures of traditional and contemporary societies and land tenure systems. Types of peasants. Peasant culture. Peasants unrest. Peasant movements and their role in agrarian structure: Santhal Insurrection (1855), Peasant revolt in Punjab (1930), Champaran

movement (1917), Kheda peasant struggle (1918), Bardoli satyagraha (1928), Moplah rebellion (1921). Peasants movement after independence. Land reforms: targets and achievements. Social impact of land reforms. Contemporary agrarian problems. Globalization and its impact on peasantry in India.

Soc. 608 Society in India **2+0** **Sem. II**

Indian Society: unity in diversity, racial and cultural composition. Ashrama system, Varna system. Sacraments and their role. Caste features and functions. Untouchability. Caste, class and kinship- tradition and change. Tribal, rural and urban society in India. Tribal Society: geographical distribution of tribes, clan, totemism, taboo, witchcraft, magic, religion, tribal development and change. Rural society, village community, tradition and change. Changing land use patterns and its consequences. Occupational mobility and its implications. Urban society, urban center, traditional and modern, urban ecology, urbanization and urbanism, urban planning and development. Increasing global interaction and changes in Indian society.

Soc. 591 Seminar

Soc. 600 Master's Research

Soc. 700 Ph.D. Research

JOURNALISM, LANGUAGES AND CULTURE

A. JOURNALISM

PROGRAMMES

MJMC (Masters in Journalism and Mass Communication)

COURSE REQUIREMENTS

MJMC

Field of Specialization	Journalism & Mass Communication
Required Courses	Jour. 501, Jour. 502, Jour. 503, Jour. 504, Jour. 505, Jour. 506 and at least one course from Jour. 507 to Jour. 509
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	English, Punjabi, Extension Education, Economics, Sociology, Business Management or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

A. Journalism

Undergraduate Courses

Jour. 302 Agricultural Journalism 2+1 Sem. II

Nature and scope of agricultural journalism. Characteristics and training of the agricultural journalist. Comparison of agricultural journalism with other types of journalism. Newspapers and magazines as communication media. Characteristics, kinds, functions, form, content, style, language and parts of newspapers and magazines. The agricultural story - types, subject matter and structure. Gathering agricultural information - sources, interviews, coverage of events, abstracting from research and scientific materials, wire services and other agricultural news sources. Writing the story - organizing the material, treatment, writing the lead and the body and readability measures. Illustrating agricultural stories - use of photographs, artwork and writing the captions. Editorial mechanics - copy reading, headline and title writing, proofreading and lay outing.

Practical: Practice in interviewing. Covering agricultural events. Abstracting stories from research and scientific materials and from wire services. Writing different types of agricultural stories. Selecting pictures and artwork for the agricultural story. Practice in editing, copy reading, headline and title writing, proofreading and lay outing. Testing copy with a readability formula. Visit to a publishing office.

Postgraduate Courses

Jour. 501 Print Journalism 1+2 Sem. I

Introduction to journalism, basic terminology, history of Indian press and printing, printing processes, attributes of a reporter, news syndicates and agencies, concept, sources and elements of news, press releases, flash messages, kinds of feature, feature, article and editorial writing, types and sources of editorials, principles of editing, headline writing, illustrations, principles of design and layout, brief introduction to recent trends in mass media, cultural imperialism, media activism, agenda setting, gate keeping, page 3 journalism.

Practical**:** Writing letters to the editor, newsgathering, writing news and headlines, conducting interviews, writing specialty stories, planning and writing features and articles, news interpretation, editorial writing, proof reading and copy editing, use of appropriate computer applications for Desk Top Publishing, dummy making, page making, production of lab journal.

Jour. 502 Online Journalism 2+1 Sem. II

Introduction to online journalism, basic terminology, a technical history of the Web and early online media, comparative media characteristics (print and online), online writing and story structure, issues in online research and information gathering, concept of interactivity and its tools, ethical dilemmas in online journalism, blogging and participatory journalism, issues concerning blogging; online advertising, virtual community formation v/s atomization, massification v/s individuation of news, understanding difference between web edition and e-edition of newspapers, metajournalism, extensions of new media e.g. RSS feeds, podcasting and wireless paper, convergence.

Practical**:** Uses of Internet, using search engines such as Google effectively, finding useful information from local, national and international sources, content writing, news-site designing, making a webpage using HTML/Front page.

Jour. 503 Media Planning and Advertising 2+1 Sem. I

Introduction to advertising, its origin and growth; terminology; advertising- its classification,

objectives, strategies at different levels and its future; marketing mix, promotional mix and the communication process; structure of advertising industry – advertising agencies; advertising coverage; types of advertising media; advertising codes, regulations and ethics; consumer redressal forums; advertising and social issues; controversial advertising; issues concerning surrogate advertising; constructing an advertisement; types of consumers and buying motives; media selection and scheduling; difference between advertising and PR; media planning and buying; brand positioning.
Practical**:** Preparing media-specific advertisement copies; ad layout and design; computer graphics using appropriate applications.

Jour. 504 Agricultural and Development Journalism 1+1 Sem. II
Meaning, scope and importance of development journalism; problems of rural development; development agencies; development media theory and democratic participant theory; dominant paradigm v/s participatory approach; human development index; making sense of development statistics; determinants of development; nation building and uplifting quality of life; agriculture and rural development schemes; agricultural news story structure, agricultural media dynamics and ethics; editing scientific papers, policy reports; public understanding and media coverage of environmental issues; use of traditional media; rural press; contribution of vernacular press; role of IT in agricultural and rural development; Right to communicate and New World Communication Order; WTO.
Practical**:** Planning and writing development articles; news and information material on farm, home and community activities; editing of popular leaflets and bulletins based on technical material; media mix campaigns for specific targets.

Jour. 505 Media Ethics and Press Laws 3+0 Sem. II
Ethics – ethical reporting, code of ethics; social responsibility; invasion of privacy; sting operations and ethical issues; organizational pressures in media ethics; **six** fundamental rights – right to equality, freedom - especially freedom of speech and expression, against exploitation, religion, cultural and educational rights, constitutional remedies; freedom and accountability of press; press laws in India; Official Secrets Act 1923 – extent, application, definitions and penalties; laws of sedition; defamation **–** criminal and civil law, exceptions and liabilities, libel and slander; Contempt of Court Act 1971 – defences and punishment; Contempt of Legislature; Privileges of the Parliament and Press; Press Council Act1978 – composition, term, objects and functions, power to censure; Press Commission; Copyright Act 1957 – meaning, term and infringements; registration of journals – Press and registration of Books Act 1867; Information Technology Act 2000 and cyber rights; Right to Information Act 2005; media's role in promotion of human rights; editor's freedom; case studies.

Jour. 506 Communication Theories and Research Techniques 2+1 Sem. I
Definition, scope and importance of communication; kinds of communication - intra-personal, inter-personal, group and mass communication, verbal and non - verbal communication; barriers of communication; communication process; diffusion process - one step, two step and multi step flow; communication models; theories: cognitive dissonance, selective exposure, perception and retention, uses and gratification approach, cultivation approach; research methods and practices for mass media; types of research e.g. survey research, readership studies, content analysis, etc.; selection and formulation of research problems; method and style of writing research report
Practical**:** Selecting a problem; conducting field surveys; writing reports; research proposal writing; conducting pilot studies and presenting reports.

Jour. 507 Corporate Communication and Public Relations 2+1 Sem. I

Corporate communication- concept, definition, nature and scope; effective means of organizational and social communication; differences between corporate communication and publicity, propaganda, advertising and lobbying; corporate citizenship and culture; function of consultancies/ image advisories; event, crisis, image and conference management; counselling, issue support; direct marketing; budgeting; business communication; publics for corporate communication; media management – principles, ownership and organizational structure in management and editorial department; circulation department; definition and scope of public relations; tools and techniques of PR; use of print media, audio-visual aids and electronic media in PR; role of public relations in various institutions; public opinion, propaganda and PR; ethics in PR.
Practical**:** Organizing exhibitions and campaigns; organizing conferences; image management of university/ college/ department; media counselling and ghost writing for organizational heads; conducting visits; motivational campaigns for organizational staff; business correspondence; liaison with administration; space marketing features; making posters, hand bills for PR campaigns.

Jour. 508 Photojournalism 1+2 Sem. I
Photojournalism – brief history and technological developments; role of photography in communication; importance and impact of pictures in publications; understanding a photograph; qualities of a good photograph; reproduction qualities of a photograph; selection and editing of photographs; writing captions; ethics of photojournalism; legal limitations of a photojournalist. Ethics and aesthetics of image manipulation.
Practical: Camera basics; terminology; components and controls in a camera; types of camera; choosing a camera; importance of lighting and natural /artificial lighting; handling a camera; camera techniques; shutter, aperture and lens controls; elements and composition; developing and printing of photographs; digital photography; file formats and storage; image editing/manipulation in Photoshop; printing and printers; photo sharing via internet; photo galleries, preparing photo features.

Jour. 509 Broadcast Journalism 1+2 Sem. I
Principles and characteristics of broadcast journalism; its comparison with print journalism; basic terminology in radio and TV journalism; history of radio and TV; early experiments and inventions; ethics in broadcasting; organization and functioning of radio and TV stations; writing for rural radio and TV programmes; differences between ham, community and FM radio; evolution of Internet Protocol TV (IPTV); steps in production including pre and post production stages; creating effective newscasts; narrowcasting v/s broadcasting; role of electronic media in rural development; impact of broadcasts and telecasts on rural life; problems of broadcasting/ telecasting.
Practical: Handling video camera, conceptualizing, drafting, interpreting and writing a radio script, drafting, interpreting and writing a TV script, preparing interview schedule for a radio/TV programme, scripting a radio/TV talk, reporting of university activities, accomplishments and research highlights through electronic media, editing scripts for development programmes on radio and TV, preparing a short documentary film.

Jour. 595 Training in Journalism 0+10 (NC) Sem.II

For practical training, students will be attached to a newspaper/news agency/radio/TV for eight weeks.

Jour. 591 Seminar

Jour. 600 Project Research

B. English
Undergraduate Courses

Eng. 91 General Reading, Vocabulary Building and Translation 2+1 Sem. I
An anthology of modern prose for intensive study, a book of biographies for general reading.
Practical: Use of articles, pronouns, conjunctions and prepositions, position and order of adverbs, tenses, paragraph writing, comprehension of unseen passages, punctuation, words often misspelt. Translation: English language into vernacular. (A special question for foreign students in lieu of translation).

Eng. 92 Reading, Comprehension, Paragraph Writing and Applied Grammar 2+1 Sem. II
An intensive study of an anthology of modern prose and poetry. A general reading of a book of biographies.
Practical: Comprehension: Review and understanding of unseen passages. Applied grammar: Use of tenses, articles, pronouns, conjunctions and prepositions, position and order of adverbs, Idiomatic verbs & phrases, words often misspelled, punctuation marks. Paragraph Writing: Important features of paragraph writing and practice. Translation: vernacular into English. (A special question for foreign students in lieu of translation).

Eng. 93 Conversational Structure and Communicative Function 2+1 Sem. I
Structure of English Language-Lexical level: structural words, content words, meaning of words, connotations and denotations, relation of words in sentences, phrasal/clausal level- phrase- form and structure, clause- form and structure, forms of sentences, sentences based on structure, function and purpose, Peculiarities of English Language- the use of articles, emphatic and personal pronouns, reduction of articles, auxiliary verbs, conjunctions, prepositions and pronouns in connected speech. Situational and functional use of English Language; factors, role of audience, managing the pace of information and delivery, time and stress management, use of factors and functions in real-life situations.
Practical: Functional use of language, greeting and introduction, request, permission, instruction and direction, offering help etc. Situational use of language- at the bank/post office/ college office, at the grocer, at the temple, at the college canteen or restaurant, at the police station, at the railway station/ bus station, at the medical shop, at the library, at the travel agency, booking a room in a hotel, facing interviews. etc.

Eng. 94 Discourse Patterns in Spoken English 1+2 Sem. II
Patterns in spoken English, back channel, deixis, clause combining, conversational historical present, discourse markers discourse markers, general extenders, hedges intensifiers, narrative structure, nonstandard grammar, non-fluency textures, repetition, false starts, quotative expressions, rhetorical strategies, slang. Discourse analysis, voice modulation, use of pitch and tone depending on the structure of sentence, importune of pause and stop in spoken English, body posture and communication.
Practical: Using language for effective communication- PowerPoint presentations, preparation and delivery of power point presentation, role of add-ons (illustrations, pictures and animations) in power point presentations, conversation with pattern and content, dialogue base study of structural patterns, activity using non-verbal skills to narrate a story/mime, voice modulation exercises, extempore and speech delivery, interview skills, soft skills, discussion skills, speaking activities, integrated task and independent task practice, role play, debates, group

discussions.

Eng. 101 General English 1+1 Sem. I & II

Reading Comprehension- Vocabulary Building- Antonyms, Synonyms, words often confused due to similar spellings or pronunciations. Functional grammar- Error Analysis- Articles, prepositions, verbs, pronouns, adjectives and adverbs. Basic sentence patterns in English- Agreement between subject and verb, proper use of phrases and clauses. Development of paragraphs- Cohesion, coherence and style. Technical Writing Skills- Nature of technical style vs. general style, writing process (prewriting, rewriting and editing). Paragraph writing, précis writing, summarizing, abstracting. Preparation of Curriculum Vitae and Job applications. Note-taking, field diary and lab record, indexing, footnote and bibliographic procedures.

Practical: Reading skills- Reading and comprehension of general and technical articles, vocabulary building tasks, exercises to help the students in the enrichment of vocabulary based on competitive examinations. Writing Skills- Note-taking, field diary and lab record, précis writing, summarizing, abstracting, preparation of curriculum vitae and job applications. Reference Skills: Use of dictionary and thesaurus, indexing, contents, glossary, footnote and bibliographic procedures.

Eng. 201 Communication Skills and Personality Development 1+1 Sem. I & II

Communication Skills- Meaning and process of communication, verbal and nonverbal communication, oral presentation skills, individual and group presentations, extempore presentations, public speaking, group discussions and interviews. Soft Skills- introduction to soft skills and hard skills. Personality- meaning and definition of personality, theoretical perspectives on personality, behavioural trait and humanistic personality patterns, molding the personality patterns. Personality development- self-perception, self-concept, self-esteem and gender stereotyping, persistence and changes in personality determinants (physical, intellectual, emotional, social, educational and family), aspirations, achievements and fulfillment. Cosmopolitan culture- presentational etiquettes, formal dressing, formal greetings. Stress and conflict management- goal setting, decision making, career planning, resume building, interview skills.

Practical: Organizing seminars and conferences, developing questionnaire to study impact of physique, educational institutions, aspirations on personality, developing questionnaire to study social prescriptions, gender and family on personality, aspirations and achievements. Oral presentation skills, video recorded mock group discussions and interviews, exercises on attitude management, setting and achieving a short term goal, creating a personal vision statement of life, practicing conscious body postures and movements, rapport building, video recorded practical to evaluate change in confidence level, team work exercises, time management.

Postgraduate Courses

PGS 501 Technical Writing, Communication Skills & Library and Information Services 1+2 Sem. I & II

Technical Writing-Various forms of technical writing-theses, technical papers, reviews, electronic communication etc., qualities of technical writing, parts of research communications-title page, content page, authorship, preface, introduction, review of literature, materials and methods, experimental results, documentation, photographs and drawings with suitable captions, pagination; citations, writing of abstracts, précis, synopsis; editing and proof reading. Communication Skills-defining communication, types of communication- verbal and non-verbal, assertive communication, assertive communication, using language for effective communication, techniques of dyadic communication- message pacing and message

chunking, self-disclosure, mirroring, expressing conversational intent, paraphrasing, vocabulary building- word roots, prefixes, Greek and Latin roots.
Practical:Editing and Proof reading technical articles; using language tools for effective writing, listening to audio-video conversations aimed at testing the comprehension of the students; oral presentations on a given topic related to agriculture, evaluation of body language and communication skills based on group discussions and interviews, role plays and pronunciation exercises, using eye contact and visual clues for effective listening skills, word stress application and voice modulation, soft skills; rhetoric skills, self-assessment exercises. Introduction to Library and its services, Five laws of library science, type of documents, classification and cataloguing, organization of documents, sources of information-primary, secondary and tertiary, current awareness and SDI services, tracing information from reference sources, library survey, preparation of bibliography, use of Online Public Access Catalogue, use of CD-ROM databases and other computerized library services, CeRA, J-Gate; use of Internet including search engines and its resources, e-resources and access methods.

Eng. 501 Advanced Comprehension and Composition 2+1 Sem. I
Comprehension of passages selected from journals, newspapers and books- style, structure and format of comprehension, prerequisites of writing a comprehension, epitomization-summaries, précis, book review, abstract and synopsis writing, diction, etymology-definitions, word meaning; denotation and connotation- definitions and meanings, concrete and abstract words-definitions and meanings, choice and arrangement of words-rules of proximity, avoiding a split infinitive, use of connectives, avoiding ambiguity, position of adverbs, clichés-idioms and phrases, figurative language, words causing confusion-metaphor, simile, homonyms, homophones, pair of words; principles of effective writing- basic units of writing- kinds of sentences, classification by function and structure, important grammatical problems, objectivity, conciseness, concreteness, directness; forms of writing- scientific and technical writing, reports, articles, papers, manuals, dissertations and theses, correspondence; styles of writing-cultural, creative, journalistic writings.
Practical: Exercises in Comprehension, epitomization-summaries, précis, abstract and synopsis writing, writing of reports and book reviews, usage and composition, writing a creative piece on a given subject. Writing of words causing confusion-metaphor, simile, homonyms and homophones. Styles of writing-cultural, creative, journalistic writings. Listening to at least two tapes regarding British pronunciation techniques, recorded conversation aimed at testing the listening comprehension of students, group discussions on the current issues concerning society, planning for meetings, holding mock meetings, facing interviews by holding mock interviews, presentations by using PowerPoint and LCD projector; public speaking on any topic.

Eng. 502 Contemporary Prose 2+1 Sem. II
Critical study of selections from contemporary prose representing creative prose-style, structure and format of prose, prerequisites of writing a prose, use of figurative language, diction, choice of words and arrangement of words, Charles Lamb- Dream Children, Bachelor's Complaint, Francis Bacon-Essays, cultural writings-style, structure and format of cultural prose, prerequisites of writing a cultural prose-glimpses of colonialism, post colonialism and Diaspora in cultural prose, scientific prose- Various forms of scientific writings-theses, technical papers, review, manuals etc., various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion) diction, choice of words and arrangement of words; journalistic writing with emphasis on Indo-Anglian Prose-Various forms of journalistic writings-Introduction, story board; style, structure and format of journalistic prose, prerequisites of writing a journalistic prose, important works of prose, especially journalistic, by western and

Indian writers known for thought and style.
Practical: Writing reviews and popular articles. Listening to at least two tapes regarding British pronunciation techniques; recorded conversation aimed at testing the listening comprehension of students; group discussions on the current issues concerning society; planning for meetings, holding mock meetings; facing interviews by holding mock interviews; presentations by using PowerPoint and LCD projector; public speaking on any topic.

Eng. 503 Communication for Management and Business 1+1 Sem. I
Communication process, barriers to communication, effective Communication, types of communication in organizations viz. downward, upward, horizontal, static vs. dynamic, business terms viz. E-mail, Fax, Internet protocol, communication through clothes, colors, space, symbol, body language and etiquettes, interpersonal communication, self-concept and communication, assertive communication, types of business writing, writing of newsletters, preparation of reports, compiling of folders, fact sheets, press release, business communication through memos, business letters, office notices, job applications; press release; advertisements; curriculum vitae; drafting minutes of a business meeting, public relations and mass communication (meaning and need for PR, seminars, methods of mass communication).
Practical:Listening to at least two tapes regarding British pronunciation techniques, recorded conversation aimed at testing the listening comprehension of students, group discussions on the current issues concerning society, planning for meetings, holding mock meetings, facing interviews by holding mock interviews, presentations by using PowerPoint and LCD projector, public speaking on any topic.

C. PUNJABI
Undergraduate Courses

Pbi. 101 Basic Punjabi 0+2 (NC) Sem. I
(For undergraduate students who have not studied Punjabi upto Matric or 10 +2 level)
Gurmukhi script, sequence of letters in Punjabi alphabet and their pronunciation, similarities and dissimilarities of gurmukhi and devnagri script, why the script of Punjabi is called gurmukhi, linguistics, definition and its application on gurmukhi script, a brief note on various dialects of Punjabi e.g. Malwai, Majhi, Doabi, Puadhi; Dogri, Kangrietc.and dialects of west Punjab, Matras, nasal sounds and their signs, word formation and pronunciation, standard spelling, correct incorrect, sentence structure, basic Punjabi grammar, idioms, proverbs, synonyms; antonyms, gender; number, one word substitution; pair of words, words having multiple meanings, agricultural terminology, paragraph, precise and letter writing, translation of simple passages from English to Punjabi, practice in spoken Punjabi, comprehension of a passage related to agriculture; practice in creative writing.

Pbi. Cul. 101 Punjabi Culture 2+0 (NC) Sem. I
(For ICAR nominees and Foreign Students)
Culture, definition, concepts and scope, Punjabi Culture, characteristics of Punjabi culture, Punjabi culture in the context of geography, history, language, literature, religion, art, folklore, fairs and festivals of Punjab as mirror of Punjabi culture, sports and games, customs, beliefs, rituals, legends and different occupations of rural Punjab, changing patterns of Punjabi culture through the ages, socio economic and political changes in Punjab in the context of changing international scenario, technical developments in the field of agriculture leading to the Green Revolution in the Punjab and its impact on the culture of the State, impact of Post- Green Revolution developments on the culture of Punjab like social tensions as result of Green Revolution, changed life styles and its impact on Punjabi culture.

Postgraduate Courses

Pbi. 501 Punjabi Literature and Culture 3+0 Sem. I

Major movements in Punjabi Culture with special emphasis on gurmat, sufi, kissa and heroic poetry, revivalistic and reformistic trends, western influence on Punjabi Culture and Literature impact of national liberation movement, progressive movement and experimental trends in Punjabi literature, Culture, concepts, scope; Punjabi culture: characteristics of Punjabi culture, Punjabi culture in the context of geography, history, language, literature, religion, art and architecture, folklore, drama and theatre, handicrafts, fairs and festivals, sports and games, customs, beliefs, values, rituals, myths and legends and religion, changing patterns of Punjabi culture through the ages, socio-economic and political changes and technological developments since partition and their impact on contemporary Punjabi culture, Punjabi ethos.

Pbi. 502 Punjabi Journalism 2+1 Sem. II

Origin and development of Punjabi journalism, contribution of Christian missionaries, role of Singh Sabha, Chief KhalsaDiwan, Akali and religious movements, secular trends, contemporary trends, prominent Punjabi dailies, weeklies and monthlies, famous Punjabi journals.

Practical: Writing articles, features and news on socio-historical and political movement, eminent personalities and writers, editing Punjabi News, translation news in Punjabi, common grammatical problems, writing headlines and photo captions in Punjabi analysis of editorials.

D. FOREIGN LANGUAGES

French 501 Proficiency in French 2+0 Sem. I & II

French alphabet and sound system (sounds of individual letters, diphthongs, rules of pronunciation etc); articles (definite, indefinite, partitive, contracted) and present tense/present perfect tense of verbs of the three groups such as parler, finir, entendre etc.; conjunctions (maiscommesi, meme si, cependant etc.) ; gender and number of nouns; conjugations (Affirmative, negative, interrogative); prepositions (sur, sous, devant, derriere, dans, a etc.) adverbs, adjectives (common adjectives which are placed before or after nouns, possessive adjectives etc.) and pronouns (simple pronouns, personnel pronouns) , cardinal numbers from 1 to 100; translation from French to English (of words, sentences and passages); accent (aigu, grave, circonflexe).

MATHEMATICS, STATISTICS AND PHYSICS

PROGRAMMES

M.Sc. **Statistics, Physics**

Ph.D. **Statistics, Physics**

COURSE REQUIREMENTS

M.Sc. (Statistics)

Field of Specialization	Design of experiments, Sample surveys, Applied statistics
Required Courses	Stat. 501, Stat. 502, Stat. 503, Stat. 504, Stat. 505, Stat. 506, Stat. 507, Stat. 508, Stat. 509
Supporting Courses	PGS 501 and courses related to area of special interest and research problem.
Minor Fields	Mathematics, Economics, Business Management, Plant Breeding & Genetics or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D. (Statistics)

Field of Specialization	Design of experiments, Sample surveys, Applied statistics
Required Courses	Stat. 601 and Stat. 602
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Mathematics, Economics, Business Management, Plant Breeding & Genetics or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

M.Sc. (Physics)

Field of Specialization	Solid State Physics, Nuclear Physics, Agricultural Physics
Required Courses	Phys. 501, Phys. 502, Phys. 503 , Phys. 504, Phys. 505, Phys. 506.
Supporting Courses	Stat. 421 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem
Minor Fields	Mathematics or any other as approved by the Dean, Postgraduate Studies
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D. (Physics)

Field of Specialization	Solid State Physics, Nuclear Physics.
Required Courses	Phys. 601, Phys. 602
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem
Minor Fields	Mathematics or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

A) MATHEMATICS

Undergraduate Courses

Math. 101 Basic Mathematics-I **3+0** **Sem. I**

Complex numbers: Properties of real numbers, complex numbers, their addition, multiplication and division, square root of complex numbers, cube roots of unity and their properties, De-Moivre's theorem; Theory of equations: Solution of quadratic equation, equation reducible to quadratic equation, relation between roots and coefficients, nature of roots and formation of quadratic equation with given roots.

Geometric series: nth term of G.P. series, sum of G.P. series, geometric mean; Harmonic series, harmonic mean; Arithmetico geometric series and special series $\sum n$, $\sum n^2$, $\sum n^3$. Partial fractions; Logarithms; Binomial theorem for any index: Expansion, middle term, general term, terms independent of x.

Trigonometry: Trigonometric ratios, allied angles, graphs of trigonometric functions; Addition and subtraction formulae; Product and sum formulae; Multiple and sub-multiple angles, sine, cosine and projection formulae; Area of a triangle.

Math. 102 Basic Mathematics –II **3+0** **Sem. II**

Matrices and Determinants- definition of matrix, addition, subtraction, multiplication and inverse of matrix. Solution of linear equations- by Crammer's rule and inverse of matrix. Functions. Limit- introduction, left handed and right handed limits, calculation of limits using standard formulae. Continuity- definition, continuity of algebraic, trigonometric and exponential functions. Differentiation- differentiation by first principle, sum, difference, product, quotient formulae, using chain rule, and of functions in parametric and implicit form, logarithmic differentiation. Geometrical interpretation of derivative. Successive differentiation. Maxima and minima. Tangent and normal. Integration- integration by substitution, trigonometric substitution, partial fractions and by parts.

Math. 103 Elementary Mathematics **2+0** **Sem. I**

Straight lines : Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope-point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form of equation of line, General form of equation of line, Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral. Circle: Equation of circle whose centre and radius is known, General equation of a circle, Equation of circle passing through three given points, Equation of circle whose diameters is line joining two points (x_1, y_1) & (x_2,y_2), Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$**.**Differential Calculus : Definition of function, limit and continuity, Simple problems on limit, Simple problems on continuity, Differentiation of x^n , e^x , sin x & cos x from first principle, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problems based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form y=f (x) (Simple problems based on it).

Integral Calculus : Integration of simple functions, Integration of Product of two functions, Integration by substitution method, Definite Integral (simple problems based on it), Area under

simple well-known curves (simple problems based on it).
Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation.

Math. 107 Fundamental Mathematics 2+1 Sem. I

Trigonometry, addition and subtraction formulae, product and sum formulae, Binomial theorem, matrices, determinants and their applications to the solution of system of equations, analytical geometry of two dimensions, equations of line and circle, functions, limit, continuity, differentiation, integration. Ordinary differential equations of first order and first degree, variable separable, homogeneous, Leibnitz linear differential equations.

Math. 201 Engineering Mathematics-I 2+1 Sem. I

Matrices: Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation,orthogonal transformations, diagonalisation of matrices, quadratic forms. PAQ form, Echelon form, Solution of linear equations, nature of rank, using Cayley-Hamilton theorem to find inverse of A. Differential calculus: Taylor's and Maclaurin's expansions; indeterminate form; curvature, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, maxima and minima. Integral calculus: volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume. Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; line, surface and volume integrals, Stoke's, divergence and Green's theorems (without proofs).
Practical: Tutorials on rank of a matrix, reduction to normal form, consistency and solution of linear equations, eigen values and eigen vectors, Cayley-Hamilton theorem, diagonalization of matrices, quadratic forms; Taylor's and Maclaurin's expansion, indeterminate form, curvature, tracing of curves, partial differentiation, maxima and minima, volume and surface of revolution, multiple integrals, Beta and Gamma functions, differentiation of vectors, gradient, divergence and curl of a vector point function, line, surface and volume integrals, Stoke's divergence and Green's Theorems.

Math. 202 Engineering Mathematics –II 2+1 Sem. II

Ordinary differential equations- exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients. Series solution techniques, Bessel's and Legendre's differential equations. Functions of a complex variable- limit, continuity and analytic function, Cauchy-Riemann equations, harmonic functions. Infinite series and its convergence. Fourier series- periodic functions, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, harmonic analysis, Fourier sine and cosine series, fourier series for function having period 2L. Infinite series, convergence of infinite series, comparison test, integral test, D'Alembert's ratio test, Raabe's and logarithmic test, Cauchy root test. Partial differential equations- formation of partial differential equations, elimination of one and two arbitrary function, higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one dimensional wave and heat flow equations, Laplace Equation).
Practical: Tutorials on solution of ordinary differential equations of first and higher orders. Series solutions of differential equations. Bessel's and Legendre's differential equations, Convergence of infinite series. Fourier series, harmonic analysis, analytical functions, Cauchy-Riemann equations,

harmonic functions. Solution and application of partial differential equations.

Math. 205 Higher Mathematics-I **2+0** **Sem. I**

Differential calculus- Taylor's and Maclaurin's expansions, indeterminate form, curvature, asymptotes, tracing of curves, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivative, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima. Integral calculus- reduction formulae, rectification of standard curves, volumes and surfaces of revolution of curves, double and triple integrals, change of order of integration, gamma and beta functions, application of double and triple integrals to find area and volume. Ordinary differential equations- exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations. Vector calculus- differentiation of vectors, scalar and vector point functions, vector differential operator del, gradient of a scalar point function, divergence and curl of a vector point function and their physical interpretations, identities involving del, second order differential operator, line, surface and volume integrals, Stoke's, Divergence and Green's theorems.

Math. 206 Higher Mathematics - II **2+0** **Sem. II**

Matrices- elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, consistency and solution of linear equations, eigen values and eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, bilinear and quadratic forms. Functions of a complex variable-limit, continuity and derivative of complex functions, analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions. Fourier and infinite series- infinite series and its convergence, periodic functions, fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, harmonic analysis. Partial differential equations- formation of partial differential equations, Lagrange's linear equation, higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one-dimensional wave and heat flow equations, two-dimensional steady state heat flow equation (Laplace equation).

Math. 207 Biomathematics **2+1** **Sem. I**

Rolle's theorem, Lagrange's theorem, Taylor's and Maclaurin's series, partial differentiation, Euler's theorem on homogeneous functions, change of variable, Jacobian, maxima and minima of two or more than two variables, eigen values and eigen vectors of a matrix. Reduction formulae, definite integrals and its applications. Solution of ordinary differential equations of first degree and first order and their application for determination of volume of blood and drug distribution, epidemic models, simultaneous differential equations of first order and their applications to predator models, linear differential equations of higher order and their applications to simple biological problem. Numerical methods for solving algebraic and transcendental equations.

Practical: Tutorials on Taylor's and Maclaurin's expansions, partial differentiation, Euler's theorem, change of variable, total derivative, implicit function, maxima and minima, eigen values and eigen vectors of a matrix, reduction formulae, definite integrals and their properties, epidemic models, predator models, determination of volume of blood and drug distribution. Ordinary differential equations of first order, linear differential equations of higher order and their applications to biological problems, numerical methods.

Math. 301 Engineering Mathematics- III **2+1** **Sem. I**

Numerical analysis and Laplace transformation- finite difference, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, Bessel's and Stirling's difference interpolation formulae, interpolation with unequal intervals. Newton's divided difference formula, Lagrange's interpolation formula. numerical differentiation, numerical integration, difference equations and their solutions, numerical solutions of ordinary differential equations by Picard's method, Taylor's series method, Euler's and modified Euler's method, Runga-Kutta method. Laplace transformation and its applications to the solutions of ordinary and simultaneous differential equations. Testing of hypothesis-level of significance, degrees of freedom, statistical errors, large sample test (Z-test), small sample test t-test (one sample, two sample and paired test), testing of significance through variance (F-test), Chi -Square test, contingency table. Correlation. Regression.
Practical: Interpolation, numerical differentiation and integration, solutions of difference equations, numerical solution of ordinary differential equations of first order and first degree, Laplace and inverse Laplace transformations and their application to solution of ordinary and simultaneous differential equations. Problems on one sample, two sample Z-tests when population S.D. is known and unknown. Problems on one sample, two sample and paired t-test. Chi-Square test – 2×2 and m × n, contingency table, calculation of correlation coefficient and its testing and F-test.

Undergraduate Elective/ M.Sc. Supporting/ Minor Courses:

Math. 421 Fundamentals of Calculus 2+0 Sem. II
Partial differentiation, maxima and minima of two or more variables, Lagrange's multipliers, implicit Function, Jacobian determinant and applications in error analysis. Integration, reduction formulae. Applications to find areas and volumes. Double integrals. Ordinary differential equations, complete solution of linear differential equations and particular solution by variation of parameters. Simultaneous linear differential equations. Application to simple economic models.

Math. 422 Matrix Algebra 2+0 Sem. I
Determinants and matrices, special types of matrices, algebraic operations, partitioning of matrices, rank of a matrix, rank of a product of matrices, inverse of a matrix by Gauss elimination, Gauss - Jordan, Crout's, Dolittle's and Cholesky's methods, bilinear, quadratic, Hermitian and skew Hermitian forms. Eigen values and eigen vectors of a matrix, bounds of eigen values and determination of eigen values by iterations. Solution of homogeneous and non-homogeneous system of linear equations using matrices.

Math. 423 Elementary Calculus for Business Management 2+0 Sem.I
Functions. Limit. Continuity. Differentiation, geometrical interpretation of dy/dx, successive Differentiation. Partial differentiation. Analytical optimization techniques. Integration and simple applications to management problems. Ordinary differential equations and their applications to management problems.

Postgraduate Courses

Math. 501/Stat. 513 Optimization Techniques 2+1 Sem.II
Convex sets. System of linear inequalities. Classical and numerical methods of optimization. Constraint optimization. Introduction to linear programming. Geometrical meaning. Simplex method. Duality theorem. Balanced and unbalanced transportation problems. Assignment problems. Two person zero sum game. Kuhn-Tucker's optimality conditions. Introduction to non-linear programming. Quadratic programming: Frank- Wolfe's method. Reduced gradient. Plane-cutting methods of solution. Integer programming: Gomory's method, branch and bound method.
Practical: Tutorial on problems on system of linear inequality. Simplex method. Transportation

problem. Assignment problem. Two person zero sum game. Kuhn-Tucker optimality conditions. Nonlinear programming. Frank-Wolfe's method. Reduced gradient. Plane-cutting methods of solution. Integer programming.

Math. 502 Computational Methods and Programming 1+1 Sem. I

Fortran-77, statement structure, algorithm structure, input/output statements, string and array manipulation. Numerical computation: numerical solution of algebraic and polynomial equations, system of linear algebraic equations, interpolation, numerical differentiation and integration, least square analysis and regression analysis.

Practical: Tutorials on: flow charting and program writing in FORTRAN-77 for the numerical methods listed in the contents.

Math. 503 Abstract Algebra and Linear Transformation 3+0 Sem. I

Group, sub-group, group of symmetries, permutation, cyclic groups and quotient groups. Lagrange's theorem. Homomorphism and isomorphism. Ring, field, integral domain and its field of quotients, subring and ideal, polynomial ring, extension and field of construction of a finite field. Vector space, subspace, basis, orthogonal basis, direct sum, quotient space, linear transformation, rank and nullity. Algebra of linear transformation, relation between linear transformation and matrix, effect of change of basis, singularity and inverse, rank of a matrix and solution of linear equations. Eigen values and eigen vectors, Cayley- Hamilton theorem, equivalence, similarity and congruence, self-adjoint, unitary and normal matrices and transformations, bilinear transformation and quadratic forms.

Math. 504 Mathematical Analysis and Topology 2+0 Sem. II

Sequences and series of real/complex numbers. Convergence and uniform convergence of sequences and series of functions. Basic concept of topology and metric spaces, completeness, connectivity, limit and continuity of functions, uniform continuity, functions of bounded variations. Riemann integration, measure space, Lebesgue measure, measurable functions, Lebesgue integration, Fatou's lemma, linear topological spaces, Banach and Hilbert spaces.Ip and Lp spaces.

Math. 505 Functions of Complex Variables 2+0 Sem. II

Functions of complex variables, analytic functions, mapping, Conformal mapping, linear transformation and mapping by other elementary functions. Schwartz-Christoffel transformation. Complex integrals, Cauchy's integral theorem, Cauchy's integral formula and evaluation of line integral by complex integration. Power series, Taylor's and Laurant's series. Integration by methods of residuals. Contour integration. Complex analytic function, potential theory and applications to two dimensional fluid flow.

Math. 506 Numerical Analysis 2+1 Sem. I

Computational errors, absolute and relative errors, difference operators, divided differences, interpolating polynomials using finite differences, Hermite interpolation, piecewise and spline interpolation, bivariate interpolation. Numerical solution of algebraic and transcendental equations by bisection, secant and Newton-Raphson's Methods, solution of polynomial equations by Birge-Vieta's, Bairstow's and Graffe's root squaring methods. Numerical differentiation based on interpolation, finite differences and undetermined coefficients. Numerical integration using methods based on interpolation and undetermined coefficients. Numerical solution of ordinary differential equations of first order and first degree by Runge -Kutta method and predictor-corrector methods. Solution of linear system of equations, Gaussian elimination method, pivoting and scaling, factorization method, iterative techniques, inverse of a matrix, computation of eigen values and eigen vectors.

Practical: Tutorials on: divided differences, Hermite and spline interpolation, bivariate interpolation,

roots of algebraic and transcendental equations by Newton-Raphson's method, bisection method, Birge-Vieta's method, Bairstow's and Graffe's root squaring methods for polynomial equations, numerical evaluation of derivatives and integral, Runge-Kutta and predictor- corrector methods, Gaussian elimination method, factorization method, iterative techniques, inverse of a matrix, eigen values and eigen vectors.

Math. 507 Numerical Methods for Ordinary and Partial Differential Equations **2+1** **Sem. II**

Interpolation. Approximation, least square and uniform approximation. Numerical differentiation and integration. Numerical solution of ordinary differential equations by single step and multi-step methods, various difference schemes for solutions of partial differential equations of parabolic, elliptic and hyperbolic types. Solution of differential equations by finite element methods.
Practical: Tutorials on: evaluation of derivatives and integrals by numerical methods, single step and multistep methods for solution of ordinary differential equations, solution of parabolic, hyperbolic and elliptic equations by finite difference methods. Finite element methods.

Math. 508 Differential Equations and Special Functions **2+1** **Sem. I**

Laplace transform, its properties and its applications for the solution of differential equations. Fourier series, Fourier integral and its applications. Series solution technique for the solution of linear ordinary differential equations of variable coefficients. Frobenius Method. Bessel equation, Bessel and Neumann functions, ber and bei functions, Airy functions, properties of Bessel and Neumann functions. Legendre equation, Legendre function, Legendre associated functions and their properties. Hermite, Laguerre and hyper-geometric equations and respective special functions. Orthogonal property of special functions. Sturm -Liouville theory of boundary value problems. Green's function as a solution technique for nonhomogeneous ordinary differential equations. Introduction of partial differential equations, variable separable technique for the solution of second order partial differential equation in cartesian, cylinderical and spherical polar coordinates, their applications from heat transfer, fluid flow and vibration of membrane.
Practical: Tutorials on: solution of differential equations by Laplace tranform, Fourier series and Fourier integral, Frobenius method, solutions of Bessel, Legendre, Hermite, Laguerre and hyper-geometric equations, Green function technique. Boundary value problems.

Math. 509 Mathematical Physics **2+0** **Sem. I**

Review of linear vector spaces. Linear operators and their algebra. Invariance and reducibility. Scalar product. Schwarz's triangle and Bessel's inequalities. Orthogonality, dual space and Gram Schmidt orthonormalization. Hilbert spaces. Cauchy convergence. Adjoint operators. Hermitian, unitary, positive and normal operators. Projections and orthogonal projection operators. Eigen values, eigen vectors and eigen values decomposition. Spectral decomposition of self-adjoint operators. Simultaneous diagonalization of normal operators. Transformation of co-ordinates. Indicial and summation conventions, covariant and contravariant vectors, invariants, higher order tensors, tensor algebra, metric tensors and raising and lowering of indices. Dirac delta function and its properties, delta sequences and their properties.

Math. 510 Functional Analysis **2+0** **Sem. I**

Linear topological spaces, normed linear spaces, completeness. Banach and Hilbert spaces, convexity, local convexity and locally convex spaces, continuous functions, linear operators and linear functions, duality bases in Banach and Hilbert spaces. Sobolov spaces, spectral theorem and applications to physical problems.

Math. 511 Theory of Calculus of Variations and Operational Calculus **2+1** **Sem. II**

Calculus of variations and variational methods for solution of boundary value problems. Laplace,

Mellin, Hankel and Fourier transforms. Solution of boundary value problems.
Practical: Tutorial on: variational calculus, solution of boundary value problems, transform methods due to Laplace, Hankel, Mellin and Fourier.

B) STATISTICS

Undergraduate Courses

Stat. 201 Elementary Statistics **2+0** **Sem. II**

Definition and scope of statistics, presentation and summarization of statistical data, frequency distribution, graphical presentation of data, measures of central tendency: mean, median, mode, geometric mean, harmonic mean. measures of dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, test of significance; Z-test for mean(s), t-test for mean(s), Chi- square test: goodness of fit test, contingency tables, correlation: Karl Pearson, Spearman's rank correlation, linear regression analysis, analysis of variance (ANOVA):one way ANOVA, elementary ideas about sampling.

Stat. 202 Biostatistics **2+1** **Sem. I**

(For 5-year Integrated M.Sc.(Hons.) programme in Chemistry)
Random Variables, Baye's theorem. Introduction to Uniform, Binomial, Poisson, Normal, Exponential and Gamma Probability distributions, Entropy, Random mating populations, Hardy-Weinberg Law, Introduction to Poisson Process and Markov chains, Random Walk models, Methods of Alignment of pairs of sequence, Sensitivity and Specificity, Chi-square test of detection and estimation of linkage, BLAST, Phylogenetic Analysis, Analysis of Variance (fixed effects) for one-way and two-way classification with interaction, Estimation and testing of heritability. Applications to molecular biology. Practical: Uniform, Binomial, Poisson, Normal, Exponential and Gamma Probability distributions, Markov Chains, Alignment of pairs of sequence, Sensitivity and specificity, Chi-square test of linkage, Phylogenetic analysis, One way and two way - Analysis of Variance, Testing of heritability, Entropy.

Stat. 205 Statistical Methods and Numerical Analysis **2+1** **Sem. I**

Frequency distribution and frequency curves. Measures of central tendency, Measures of dispersion. Normal distribution and its application. Introduction to sampling. Statistical methods, testing of hypothesis, concepts, testing of significance based on Z-test, t-test, F-test, Chi-square test, contingency table, correlation, regression, testing of significance of correlation and regression. ANOVA-one-way and two-way classifications, factorial experiment concepts (2^2, 2^3). Numerical analysis - finite differences, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, numerical integration by Trapezoidal, Simpson's rules. Numerical solution of ordinary differential equations, Runge-Kutta method. Laplace transforms- definition of Laplace transform, properties of Laplace transforms, inverse Laplace transforms, transforms of derivatives, integrals, transform of function multiplied by t^n, transform of function divided by t, application of Laplace transforms to solve ordinary differential equations. Experimental designs- basic designs, completely randomized design (CRD) - layout and analysis with equal and unequal number of observations, randomized block design (RBD) - layout and analysis, Latin square design (LSD) – layout and analysis
Practical : Problems on one sample, two sample Z-tests when population S.D. is known and unknown. Problems on one sample, two sample and paired t-test. Chi-square test – 2×2 and m×n contingency table and F-test. Calculation of correlation coefficient and its testing. Fitting of simple linear regression. ANOVA-one way/two way, 2^2, 2^3. Problems on Newton's forward and backward interpolation formula for equal intervals. Problems on trapezoidal rule, Problems on Simpson's 1/3 and 3/8 rules. Problems on solution of ordinary differential equations of first order and second

orders by Runge-Kutta method. Problems on Laplace transforms. Problems on inverse transformations. Problems on solutions of first order differential equations.

Stat. 206 Basic Statistics 1+1 Sem. II

Definition of statistics, its use and limitations. Frequency distribution and frequency curve and cumulative frequency curve. Measures of central tendency. Measures of dispersion. Probability-definition, additive and multiplicative law for two events. Normal distribution and its properties. Introduction to sampling. Sampling techniques. Tests of significance- null hypothesis, alternate hypothesis, type I & II error, one and two tail tests, level of significance and confidence interval. SND test for means. Single sample and two samples Z-test. Student's t-test for means, single sample, two samples and paired t-test, F-test. Chi-square test in 2x2 contingency table, Yate's correction for continuity. Correlation- scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing. Linear regression and its properties. Analysis of variance and its assumptions, analysis of CRD ,RBD and Latin square designs.

Practical : Construction of frequency distribution tables and frequency curves. Computation of arithmetic- mean, median, mode. standard deviation, variance and coefficient of variation for ungrouped and grouped data. SND test for means, Student's t-test, F-test . Chi-square test. Correlation coefficient 'r' and its testing. Fitting of regression equations. Analysis of CRD, RBD, LSD.

Stat. 207 Principles of Statistics 2+1 Sem. I

Introduction to statistics, uses and limitations. Qualitative and quantitative classification of data, discrete and continuous variables, frequency tables, grouped and ungrouped data. Diagrammatic representation of data. Graphical representation of data -histogram, frequency polygon, frequency curve, ogives. Measures of central tendency (AM, GM, HM, median. mode with merits, demerits and uses). Measures of dispersion-range coefficients, inter quartile range, quartile deviation, coefficient of quartile deviation, mean deviation from mean, median and mode, variance, standard deviation, coefficient of variation. Moments. Measures of skewness and kurtosis. Probability theory-definition of probability and its laws. Definition of random variable, discrete and continuous random variables, probability distribution of random variable, basic concept of binomial distribution, Poisson distribution, normal distribution and its applications. Correlation and linear regression analysis. Tests of significance - basic definitions null and alternative hypothesis, tests statistic, testing of hypothesis, one sample and two sample Z & t-tests. Chi-square test of goodness of fit and Chi-square test of independence of attributes. Analysis of variance definition and analysis of one way classified data. Introduction to sampling methods- definition of population, random sample, sampling versus complete enumeration, use of random number table for selecting a simple random sample, simple random sampling with and without replacements.

Practical: Graphical representation of data. Diagrammatic representation of data. Measures of central tendency (ungrouped and grouped data) with calculation of quartiles, deciles and percentiles. Measures of dispersion (ungrouped and grouped data). Moments- measures of skewness and kurtosis (ungrouped and grouped data). Correlation and regression analysis. Application of one sample and two sample Z-test and Fisher's t-test . Chi-square test of goodness of fit. Chi-square test of independence of attributes. Analysis of variance one way classification .Selection of random sample using simple random sampling.

Stat. 302 Fundamentals of Biostatistics 2+1 Sem. II

(For B.Tech.(Biotechnology))

Random variables- expected value and its variance. Probability distribution of random variables, conditional probability, Baye's theorem and its applications. Introduction to uniform, binomial, Poisson, normal, exponential and gamma probability distributions. Random mating populations, Hardy-Weinberg Law. Introduction to Poisson process and Markov chains, transition probability

matrix, n-step transition probabilities, steady states, random walk models, sensitivity and specificity. Chi-square test- testing heterogeneity, use in genetic experiment, detection of linkage, linkage ratios and its estimation. Analysis of variance- One-way and two-way classification with interaction. Analysis of covariance. Incomplete block designs. Estimation and significance of genotypic and phenotypic variation.

Practical: Expected value and variance of discrete and continuous distributions- uniform, binomial, Poisson, normal, exponential and gamma probability distributions. Hardy-Weinberg law. Construction of transition probability matrix in Markov chains. Calculation of sensitivity and specificity. Detection and linkage using Chi-square test. One-way and two-way analysis of variance. Analysis of covariance. Incomplete block designs. Testing of heritability.

Undergraduate Elective/M.Sc. Supporting/Minor Courses

Stat. 421 Statistical Methods for Research Workers 2+1 Sem. I & II

Probability and probability distributions. Principle of least squares. Linear and non-linear regression. Multiple regression. Correlation analysis. Selection of variables. Validation of models. Sampling techniques. Determination of sample size. Sampling distribution of mean and proportion. Hypothesis testing. Concept of p-value. Student's t-test. Chi- square test and large sample tests. Confidence intervals. ANOVA and testing of hypothesis in regression analysis. Analysis of variance for one way and two way classification (with equal cell frequency). Transformation of data. Advantages and disadvantages of non- parametric statistical tests. Scales of measurements. Sign test. Median test. Run-test. Wilcoxon signed rank test, Mann- Whitney test. Chi-square test for two independent samples. Kruskal-Walli's one way and Friedman's two way ANOVA by ranks. Kendall's Coefficient of concordance.

Practical: Fitting of distributions. Sample and sampling distributions. Correlation analysis. Regression analysis (exponential, power function, quadratic, multi-variate, selection of variables, validation of models, ANOVA and testing of hypothesis). Tests of significance (Z-test, t-test, F-test and Chi-square test). Analysis of variance. Non-parametric tests.

Stat. 422 Experimental Designs for Research Workers 2+1 Sem. II

Need for designing of experiments: characteristics of good designs. Basic principles of experimental designs. Uniformity trials. Size and shape of plots and blocks. Review of completely randomized design, randomized block design and latin square designs. Missing plot techniques and analysis of covariance in randomized block designs and latin square designs. Multiple comparison tests. Factorial experiments: interpretation of main effects and interactions. Orthognality and partitioning of degrees of freedom. Confounding in 2^3, 2^4, 3^2 and 3^3 designs. Factorial experiments with control treatment. Split plot design. Factorial in split plot design. Strip plot design. Crossover designs. Balanced incomplete block design . Lattice design. Alpha design. Response surface designs. Groups of experiments.

Practical: Uniformity trials. Completely randomized design. Randomized block and latin square designs. Missing plot and analysis of covariance. 2^3, 2^4 and 3^3 simple and confounded experiments. Split plot designs. Factorial in split plot designs. Strip plot designs. Cross over and balanced incomplete block designs. Lattice designs. Groups of experiments.

Postgraduate Courses

Stat. 501 Probability Theory 2+0 Sem. I

Sample space. Probability: classical, empirical and axiomatic definitions. Univariate and bivariate random variable. Mathematical expectation and its laws. Probability generating function. Distribution function. Characteristic function. Moment generating function. Moments. Cumulants. Stochastic convergences. Weak and strong laws of large numbers. Tchebychev's and Kolmogorov's inequalities. Central limit theorems. Elementary concepts of stochastic processes. Markov chains and random walk models.

Stat. 502 Statistical Methods **2+1** **Sem. I**

Probability distribution: uniform, binomial, Poisson, geometric, hyper geometric, negative binomial, multinomial, normal, exponential, Cauchy, Gamma, Beta, Weibull, log normal, logistic and Pareto. Compound and truncated distributions. Central and non-central z, t and F. Bivariate normal and sampling distributions of correlation and regression coefficients. Distribution of quadratic forms and r-th order statistic.

Practical: Random experiments. Moments. Correlation and regression. Fitting of: binomial, Poisson, normal, hyper geometric and negative binomial. Truncated binomial and Poisson. Log normal.

Stat. 503 Statistical Inference **3+1** **Sem. I**

Point and interval estimation. Criterion of good estimator. Least squares. Moments. Minimum Chi-square and maximum likelihood methods of estimation. Cramer-Rao inequality. Rao-Blackwell theorem. Sufficient statistics. Theory of testing of hypothesis. Neyman-Pearson Lemma. Likelihood ratio test. Best critical region. Most powerful and uniformly most powerful tests. Testing of simple and composite hypothesis. Sequential analysis. Wald's sequential probability ratio test. Average sample number and operating characteristic curve. Loss, risk and decision functions. Bayesian inference. Non- parametric tests: Sign test, Wilcoxon signed rank test, Runs test for randomness, Kolmogorov - Smirnov test for goodness of fit, Median test and Mann-Whitney U-test. Chi-square test for goodness of fit and test for independence of attributes. Kruskal-Wallis and Friedman's tests. Spearman's rank correlation and Kendall's Tau tests for independence.

Practical: Methods of estimation : maximum likelihood, minimum z^2 and moments. Confidence interval estimation. MP and UMP tests. Large sample tests. Non-parametric tests. Sequential probability ratio test. Decision functions.

Stat. 504 Theory of Multivariate Techniques **2+1** **Sem. I**

Random vector. Multivariate normal distribution and its properties. Conditional and marginal distributions. Sampling distribution of mean vector. ML estimates of mean vector and dispersion matrix. Wishart's distribution. Hotelling's T^2. Multivariate analysis of variance of one and two way classified data. Population and sample principal components. Large sample inferences. The orthogonal factor model. Factor rotation. Interpretation of factor analysis. Canonical correlations and their interpretations. Classification and discrimination procedures for discrimination between two known populations. Likelihood ratio rule. Tests associated with discriminant function. Classification of several populations. Fisher's method for discriminating among several populations. Clustering methods. Path analysis: computation of path coefficients.

Practical : Hotelling's T^2 (one and two sample). MANOVA (One way and two way classification). Principal component analysis. Factor analysis.Canonical correlation. Discriminant analysis (overall and stepwise). Classification. Cluster analysis using Euclidean distance. Path analysis.

Stat. 505 Theory of Designs and Analysis of Experiments **3+1** **Sem. II**

Designing of experiments. Analysis of variance. Linear estimation and tests of statistical hypothesis for completely randomized design. Designs eliminating one way heterogeneity: randomized block design, balanced incomplete block and partially balanced incomplete block designs. Fixed, mixed and random effect model (two-way classification only). Designs eliminating two way heterogeneity: Latin square, Youden square. Analysis of covariance. Missing plot techniques. Mixed up observations. Analysis of factorial experiments. Confounding. Split plot design. Construction of mutually orthogonal Latin squares. Balanced incomplete block design. Partially balanced incomplete block designs (two associate classes). Confounding in symmetrical factorial experiments. Fractional replications. Weighing designs. Optimal designs. Optimality criteria. Response surface designs. Repeated measurements designs. Combined analysis of experiments.

Practical: Estimation and testing of hypothesis. Analysis of : completely randomized, randomized

block and latin square designs. Inter and intra block analysis of balanced incomplete block design. Two associate classes partially balanced incomplete block designs. Missing observations. Analysis of covariance. Two factor non-orthogonal data with and without interaction. Factorial experiments. Split-plot design. Response surface design. Repeated measurements designs. Combined analysis of experiments.

Stat. 506 Theory of Sampling Techniques 3+1 Sem. I

Steps involved in sample survey. Sample size determination. Design and organization of pilot and agricultural sample surveys. Basic sampling schemes : simple random sampling with and without replacement. Unequal probability sampling with and without replacement. Stratified sampling : allocation problem and construction of strata. Systematic sampling. Related estimators of : population total/mean, their variances and variance estimators. Sampling and sub-sampling of clusters. Multi-stage sampling : two- stage sampling with equal/unequal number of second stage units and simple random sampling without replacement/unequal probability sampling with replacement at first stage. Ratio estimator. Product estimator. Difference estimator. Regression estimator. Ratio estimation in two-stage sampling. Double sampling. Non sampling errors: their control and estimation. Randomized response technique : the Warner model and the unrelated question models. Introduction to Jackknife and Bootstrap-methods for estimating bias. Standard error. Recent developments in sampling.

Practical : Determination of sample size. Sample selection. Estimation of: population total/mean, proportion and estimation of their variances in SRS, PPS, stratified, systematic and multistage sampling. Construction of strata. Estimation of: population total/mean in ratio, regression methods of estimation and estimation of their MSE's. Application of randomization devices.

Stat. 507 Regression Analysis 1+1 Sem. I

Least square estimation. Generalized least squares. Multiple: regression and correlation. Tests of linear hypotheses. Polynomial regression: orthogonal polynomials. Tests of fit of a model. Q-Q plots. Transformations. Detection of outliers. Departures from the usual assumptions: heteroscedasticity, autocorrelation, multicollinearity, non-normality- detection and remedies. Variable selection. Non- linear models. Weighted least square method. Use of dummy variables. Stepwise regression.

Practical : Linear Regression. Comparing regression lines. Two phase linear regression. Fitting of multiple regression model. Hypothesis testing. Confidence intervals. Goodness of fit test. Analysis of residuals: normal plot, Q-Q plot, etc. Cook's distance for outlier identification. Polynomial regression. Tests for: heteroscedasticity, multicollinearity and non-normality. Choosing the best regressor. Orthogonal polynomials. Stepwise regression. Non-linear models.

Stat. 508 Statistical Computing 1+1 Sem. II

Introduction to statistical packages. Computing: data types and structures, classification, association rules and graphical methods. ANOVA. Regression. Categorical data methods. Model formulation: fitting, diagnostics and validation. Matrix computations in linear models. Analysis of discrete data. Numerical liner algebra. Numerical optimization. Graphical techniques. Numerical approximations. Analysis of cohort studies. Case-control studies. Randomized clinical trials. Techniques in the analysis of : survival data and longitudinal studies.

Practical: Data management. Graphical presentation of data. Descriptive statistics. General linear models: fitting and analysis of residuals. Outlier detection. Categorical data analysis. Analysis of discrete data. Analysis of binary data. Numerical algorithms. Cohort studies. Clinical trials.

Stat. 509 Time Series Analysis 1+1 Sem. II

Components of time series. Autocorrelation. Partial autocorrelation functions. Correlogram. Periodogram analysis. Linear : stationary and non-stationary models. Autoregressive integrated

moving average (ARIMA) models. Forecasting-Box Jenkins models. Model: identification and estimation. Seasonal models. Intervention analysis. Outlier detection.
Practical: Auto-correlation. Auto-regressive models: first and second order lag. Moving average linear filtering. ARIMA models. Periodic data seasonal differencing. Model selection techniques. Serial correlation. Exponential smoothing. Fourier/ periodogram analysis.

Stat. 510 Actuarial Statistics 2+0 Sem. I
Insurance. Utility theory. Models for claims. Survival function. Curtate future lifetime. Life tables. Assumptions for fractional ages. Laws of mortality. Multiple life functions. Joint : life and last survivor status. Insurance annuity benefits. Multiple decrement models. Deterministic random survivorship groups. Single decrement tables. Premiums. Evaluations. Distribution of aggregate claims. Compound Poisson distribution: applications. Principles of compound interest. Nominal effective rates of interest and discount. Accumulation factor. Continuous compounding. Death-level benefit insurance. Endowment insurance. Deferred insurance. Varying benefit insurance. Recursions. Commutation functions. Continuous and discrete life annuities. Continuous and discrete net premium. Recursive formulas. Differential equations for reserves. Commutation functions. Premiums that include expenses. Stop-loss insurance.

Stat. 511/Econ. 503 Econometrics 2+1 Sem. II
Introduction: relationship between economic theory, mathematical economics, models and econometrics. Methodology of econometrics. Representation of economic phenomenon. Relationship among economic variables. Linear and non-linear economic models. Analysis of economic time series components : their interpretation. Ordinary least .squares methods of estimation of: simple and multiple regression models. The BLUE properties of least squares estimate. Tests of significance. Confidence intervals. Indirect least square method of estimation. Maximum likelihood estimation. Problems of: multicollinearity, heteroscedasticity and autocorrelation. Principal component analysis. Use of dummy variables. Generalized Aitkin's least squares methods of estimation. Distributed lag models. Estimation from grouped data. Application of computer software for solving practical econometric problems. Simultaneous equation models : structural equations, reduced form equations, identification and approaches to estimation.
Practical: Practicals on single equation two variable model specification and estimation. Hpothesis testing. Transformations of functional forms and OLS application. Estimation of multiple regression models : hypothesis testing, testing and correcting specification errors, testing and managing multicollinearity, heteroscedasticity and autocorrelation. Estimation of regressions with dummy variables. Estimation of regression with limited dependent variable. Identification of equations in simultaneous equation systems.

Stat. 512 Statistical Quality Control and Data Mining 2+0 Sem. II
Basic concepts of process monitoring and control. Theory of control charts. O.C. and ARL of control charts. CUSUM charts using V-mask. Decision intervals. Economic design of x-bar chart: single, double, multiple, sequential sampling plans and their properties. Methods for estimating (n, c) using large sample. Bayesian techniques. Curtailed and semi-curtailed sampling plans. Dodge's continuous sampling inspection plans for inspection by variables for: one-sided and two-sided specifications. Basic concepts of 6σ - DMAIC: approach and the metrics used. Basic ideas of response surface: methodology and contour plots. Taguchi methods for off-line control. Concepts of data mining. Clustering methods from: statistical and data mining viewpoints. Vector quantization. Unsupervised learning. Supervised learning. Artificial neural networks.

Stat. 513 /Math. 501 Optimization Techniques 2+1 Sem. II
Convex sets. System of linear inequalities. Classical and numerical methods of optimization. Constraint optimization. Introduction to linear programming. Geometrical meaning. Simplex method.

Duality theorem. Balanced and unbalanced transportation problems. Assignment problems. Two person zero sum game. Kuhn-Tucker's optimality conditions. Introduction to non-linear programming. Quadratic programming: Frank- Wolfe's method. Reduced gradient. Plane-cutting methods of solution. Integer programming: Gomory's method, branch and bound method.
Practical: Tutorial on problems on system of linear inequality. Simplex method. Transportation problem. Assignment problem. Two person zero sum game. Kuhn-Tucker optimality conditions. Non- linear programming. Frank- Wolfe's method. Reduced gradient. Plane-cutting methods of solution. Integer programming.

Stat. 514 Statistical Ecology **2+0** **Sem. I**

Ecological data. Ecological sampling. Spatial pattern analysis: distribution methods. Quadrant-variance methods. Distance methods. Species-abundance relations: distribution models. Diversity indices. Species affinity: Niche-overlap indices. Interspecific association. Interspecific covariation. Community classification: resemblance functions. Association analysis. Cluster analysis. Community Ordination: polar ordination. Principal component analysis. Correspondence analysis. Nonlinear ordination. Community interpretation: classification, interpretation and ordination interpretation.

Stat. 515 Computer Programming in Statistical Research **2+1** **Sem. I**

Computer and computer language. Discussion of algorithms for development of computer programmes: linear, multiple regression, correlation coefficient, completely randomized design, randomized block design, latin square design and analysis of variance of two way classification with unequal cell frequency. Application of EXCEL for various statistical methods.
Practical: Writing of programmes in FORTRAN/C^{++} on all the above topics. Use of EXCEL in descriptive statistics. Z-test. t-test. ANOVA (one, two-way classification). Correlation analysis. Multiple regression. Curve fitting.

Stat. 521 Multivariate Statistical Methods **2+1** **Sem. II**

Multivariate normal distribution. Hotelling's T^2 for testing of hypothesis. Multiple regression. Multivariate analysis of variance. Classificatory problems. Discriminant function. Principal components. Canonical analysis. Factor analysis. Cluster analysis. Use of D^2 statistics in biological applications.
Practical: Hotteling's T^2 statistic. Fitting and testing in multiple regression. MANOVA (one way and two way classification). Canonical analysis. Discriminant analysis. Principal components. Factor analysis.

Stat. 522 Designs of Surveys **2+1** **Sem. II**

Importance of sample surveys. Designing of a survey. Preparation of questionnaire. Sampling from finite population: simple random sampling. Determination of sample size. Probability proportional to size sampling. Stratified sampling: cumulative cube root method. Systematic sampling. Cluster sampling. Multistage sampling. Ratio, product and regression method of estimation. Double sampling. Successive sampling, Randomized response technique.
Practical: Sample selection in various sampling schemes . Estimation of parameters in simple random sampling. Probability proportional to size sampling. Stratified sampling. Systematic sampling. Cumulative cube root method. Multistage sampling. Ratio, product and regression method of estimation. Double Sampling.

Stat. 523 Applied Regression Analysis **2+1** **Sem. II**

Correlation measures. Correlation from grouped data. Biserial correlation. Rank correlation: their testing. Multiple and partial correlation coefficients and their testing. Autocorrelation. Durbin Watson Statistic. Removal of autocorrelation by transformation. Analysis of collinear data. Multicollinearity.

Method of least squares for curve fitting. Simple and multiple regressions. Testing of regression coefficients. Examining the multiple regression equation. Weighted least square. Regression equation for grouped data. Selecting the best regression equation. Regression approach applied to analysis of variance in one way classification. Heteroscedastic models. Nonlinear regression and fitting of quadratic, exponential and power curves. Economic and optimal dose. Orthogonal polynomial.
Practical: Correlation coefficient. Various types of correlation coefficients: partial and multiple. Testing of hypotheses. Multiple linear regression analysis. Partial regression coefficients. Testing of hypotheses. Residuals and their applications in outlier detection. Handling of correlated errors. Multicollinearity. Fitting of quadratic, exponential and power curves. Fitting of orthogonal polynomials.

Stat. 524 Economic Statistics 2+1 Sem. II

Time series analysis. Decomposition of time series into different components. Measurement of trend. Measurement of seasonality. Method of simple average. Ratio to trend method. Ratio of moving average method. Link relative method. Index numbers. Utility of index numbers. Different types of index numbers. Criterion for ideal index number. Base shifting. Splicing. Deflating index number. Time series and problem of heteroscedasticity. Autocorrelation. Confidence interval for forecasting estimation. Engel's law and its curve. Periodogram analysis. Forecasting methods using regression. Exponential smoothing. ARIMA models and non-linear models with time series data. Measuring forecasting error.
Practical: Decomposition of time series into different components. Measurement of trend using linear, quadratic, exponential, modified exponential, Gompertz, logistic, etc. Measurement of seasonality using simple average, ratio to trend, ratio of moving average method, link relative method. Index numbers: different types of index numbers. Autocorrelation. Confidence interval for forecasting estimation. Engel's law and its curve. Periodogram analysis. Forecasting methods using regression, exponential smoothing and ARIMA models.

Stat. 525 Data Analysis Using Statistical Packages 1+1 Sem. II

Use of software packages for: summarization, tabulation. Descriptive statistics. Graphical representation. Exploratory data analysis. Testing the goodness of fit of discrete and continuous probability distributions. Testing of hypotheses using Z, Chi- square, t and F statistic. Analysis of variance and covariance for single factor, multi- factor, one way and multi-classified data. Multiple comparisons. Analyzing crossed and nested classified designs. Correlation and regression. Multiple regression. Discriminant function. Factor analysis. Principal component analysis. Analysis of time series data. Fitting of non-linear models.
Practical: Use of software packages for summarization, tabulation. Descriptive statistics. Graphical representation of data. Testing linearity and normality assumption. Testing of goodness of fit of probability distributions. Testing the hypotheses (large samples, t, Chi- square and F test). One way analysis of variance. Multiway classified analysis of variance : cross-classification, nested classification, factorial set up. Generalized linear models. Linear regression. Multiple regression. Variable selection. Regression statistic. Fitting of growth models. Time series analysis: autocorrelation, correlogram and periodogram. Linear stationary model. Linear non-stationary model. Model identification and model estimation. Intervention analysis and outliers detection.

Stat. 526 Non-parametric Statistics 2+1 Sem. II

Parametric versus non-parametric tests. Scales of measurements. Current tests of hypotheses when distribution is not specified. Rank and permutation tests of one, two and k samples. Co-efficient of concordance. Application in biological and sociological work.
Practical: One sample: binomial and Chi- square tests, sign test and Wilcoxon signed rank test, median test and run test. Two sample: Fisher's exact test, Wilcoxon and Mann- Whitney test, Kolmogorov and Smirnov test. K- sample: Friedman's two way analysis by ranks, Kruskal -Wallis one way analysis by ranks, Kendall's partial tau statistic and Kendall's coefficient of concordance.

Stat. 527/ABM 512/Mgt. 512/Econ. 508 Quantitative and Optimization Techniques for Economics and Management **2+1** **Sem. II**

Role of quantitative methods in decision making. Probability and decision making under risk and uncertainty. Value of additional information. Bayes theorem. Probability models and decision making. Sample survey methods. Measurement and forecasting. Index numbers. Time series analysis. Optimization models. Linear programming: formulation and simplex method, primal and dual, sensitivity analysis. Transportation models and assignment models. Dynamic programming. Network analysis. PERT and CPM. Game Theory: concept, two person constant sums, zero sum games, saddle point, solution to mixed strategies. Markov chain analysis. Queuing models: waiting line problem, characteristics of waiting lines, single- channel model, multiple-channel model, constant- service time model, finite population model, sequencing and replacement models. Simulation and Monte Carlo methods.
Practical: Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex method. Formulation of simplex method by typical farm situations. Solution of other numerical problems. Case studies, analysis and discussion.

Stat. 601 Advanced Statistical Inference **3+0** **Sem. I**

Robust estimation, M-estimates. L-estimates, asymptotic techniques. Bayesian inference. Logliner models. Saturated models. Hierarchical models. Analysis of multi- dimensional contingency tables. Non- parametric maximum likelihood estimation. Density estimation. Rosenblatts naïve estimator. Asymptotic normality of Kernel estimates. Consistency and asymptotic normality (CAN) of real and vector parameters. Invariance of CAN estimators. Generation of CAN estimators using central limit theorem. Multinomial distribution. Cramer-Huzurbazar theorem. Efficiency: asymptotic relative efficiency and Pitman's theorem. Bahadur efficiency and Hodges-Lehmanns efficiency. Rao's second order and Hodges-Lehmann's efficiency. Rank tests. Permutation tests. Markov Chains: maximum likelihood estimation and testing of transition probability matrix of a Markov Chain. Concept of loss, risk and decision functions. Admissible and optimal decision functions. A priori and posteriori distributions. Conjugate families. Bayes and Minimax decision rules. Estimation and testing viewed as cases of decision problems. Concept of Bayesian sequential analysis. Minimax sequential procedure. Kernel. Symmetric kernel. U-statistics: variance and covariance. Hoeffding's decomposition of U-statistics. Estimation of standard and biased deviation of point estimator by Jackknife, Bootstrap, Infinitesimal Jackknife, Delta and influence function methods.

Stat. 602 Advanced Statistical Computing **2+1** **Sem. I**

Measures of association. Structural models. Estimation in complete tables. Goodness of fit. Choice of a model. Generalized Linear Model for discrete data. Poisson and Logistic regression models. Log-linear models. Cross-classification tables. Models for nominal and ordinal response. Robust linear regression. Nonlinear and generalized linear regression. Tree-structured regression and classification. Cluster analysis. Robust multivariate analysis. Markov Chain. Monte Carlo and annealing techniques. Neural networks. Association rules and learning algorithms. Linear mixed effects models. Methods for fitting models and dropout or other missing data. Multivariate tests of linear hypotheses. Multiple comparisons. Confidence regions. Prediction intervals. Statistical power.

Transformations and diagnostics. Growth curve models. Dose-response models.
Practical: Generalized linear models for discrete data. Robust methods for testing of non-normal data. Robust multivariate analysis. Cluster analysis. Classification and prediction using artificial neutral networks. Markov Chain. Analysis of data using linear mixed effects models and missing observations. Multiple comparison procedures. Confidence intervals. Fitting of growth curve models to growth data. Fitting of dose- response curves and estimation of parameters.

Stat. 603 Advanced Statistical Methods 2+0 Sem. I
Ridge regression: basic form. Use as a selection procedure. Robust regression: least absolute deviations regression, M-estimators and least median of squares regression. Non-parametric regression. Fitting of logistic regression. Poisson regression. Ridge regression. Robust regression. Non-parametric regression. Theory and applications of generalized models. Fixed effects. Random effects and mixed effects models. Estimation of variance components from unbalanced data. Unified theory of least squares. MINQUE, MIVQUE and REML. Quasi-likelihoods and generalized estimating equations. Logistic regression. Over-dispersion, Poisson regression. Log-linear models. Conditional likelihoods. Generalized mixed models and regression diagnostic. Theory of statistical methods for analyzing categorical data by means of linear models. Multifactor and multi-response situations: interpretation of interactions.

Stat. 604 Advanced Design of Experiments 2+0 Sem. II
General properties and analysis of block designs. Balancing criteria. M-associate PBIB designs: their association schemes, properties and construction. Designs for test treatment : control(s) comparisons. Nested block designs. Mating designs. General properties and analysis of two-way heterogeneity designs. Youden designs. Structurally incomplete block designs. Designs for two sets of treatments. Balanced factorial experiments (symmetrical and asymmetrical factorials). Factorial experiments with extra treatments(s). Orthogonal arrays. Mixed orthogonal arrays. Balanced arrays. Fractional replication. Regular and irregular fractions. Response surface designs : symmetrical and asymmetrical factorials. Response optimization. Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors. Optimality criteria and optimality of designs. Robustness of designs. Diagnostics in design of experiments.

Stat. 605 Advanced Sampling Techniques 2+0 Sem. II
Use of combinatorics in controlled selection. Two way stratification. Collapsed strata. Systematic sampling in two dimensions. Integration of surveys : Lahiri and Keyfitz's procedures. Variance estimation in complex surveys. Taylor's series linearization. Balanced repeated replication. Jackknife and bootstrap methods. UMV : Non-existence theorem and existence theorem under restricted conditions. Concept of sufficiency and likelihood in survey sampling. Admissibility and hyper-admissibility. Inference under super population models : concept of designs and model unbiasedness and prediction approach. Regression analysis and categorical data analysis with data from complex surveys. Domain estimation. Small area estimation. Stochastic parameter models. Bayesian models with multi-stage sampling. Time series approach in survey sampling. Dynamic Bayesian prediction. Kalman filter. Empirical and Hierrchical Bayes predictors. Robust linear prediction.

Stat. 606 Advanced Time Series Analysis 2+0 Sem. II
Multivariate time series. Stationary VAR models: properties, estimation, analysis and forecasting. VAR models with elements of nonlinearity. Non-stationary multivariate time series: spurious regression, co- integration and common trends. Volatility: modelling the variance. The class of ARCH models: properties, estimation, analysis and forecasting, stochastic volatility and realized volatility. Extensions: IGARCH, ARCH-t, ARCD, multivariate GARCH, time-varying risk and ARCH-in-mean. Structural time-series modeling: state space models, Kalman filter. Local level model.

Local linear trend model. Seasonal models. Cyclical models. Nonlinear time-series models: parametric and nonparametric approaches. Autoregressive conditional heteroscedastic model and its extension. Threshold and functional coefficient autoregressive models. Non-linear programming: Kuhn-Tucker sufficient conditions. Elements of multiple objective programming. Dynamic Programming. Optimal control theory : Pontryagin's maximum principle.

Stat. 591 Seminar

Stat. 600 Project Research

Stat. 700 Ph.D. Research

C) PHYSICS

Undergraduate Courses

Phys. 91 Mechanics **4+1** **Sem. I**

Physical World and Measurement: Physics - scope and excitement, nature of physical laws, physics, technology and society. Need for measurement: units of measurement, systems of units, SI units, fundamental and derived units, Length, mass and time measurements, accuracy and precision of measuring instruments, errors in measurement, significant figures, dimensions of physical quantities, dimensional analysis and its applications. Kinematics: frame of reference, motion in a straight line, position-time graph, speed and velocity, uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity-time, position-time graphs, relations for uniformly accelerated motion (graphical treatment), elementary concepts of differentiation and integration for describing motion, Scalar and vector quantities: position and displacement vectors, general vectors and notation, equality of vectors, multiplication of vectors by a real number, addition and subtraction of vectors, relative velocity. Unit vector: resolution of a vector in a plane - rectangular components, scalar and vector product of vectors, motion in a plane, cases of uniform velocity and uniform acceleration projectile motion, uniform circular motion. Laws of Motion: intuitive concept of force, inertia, Newton's first law of motion; momentum and Newton's second law of motion, impulse, Newton's third law of motion, law of conservation of linear momentum and its applications, equilibrium of concurrent forces, static and kinetic friction, laws of friction, rolling friction, lubrication, dynamics of uniform circular motion, centripetal force, examples of circular motion(vehicle on level circular road, Vehicle on banked road).Work, Energy and Power: work done by a constant force and a variable force; kinetic energy, work-energy theorem, power, notion of potential energy, potential energy of a spring, conservative forces: conservation of mechanical energy (kinetic and potential energies); non- conservative forces, motion in a vertical circle; elastic and inelastic collisions in one and two dimensions. Motion of System of Particles and Rigid Body**:** centre of mass of a two-particle system, momentum conversation and centre of mass motion, centre of mass of a rigid body; centre of mass of uniform rod, moment of a force, torque, angular momentum, conservation of angular momentum with some examples; equilibrium of rigid bodies, rigid body rotation and equations of rotational motion, comparison of linear and rotational motions; moment of inertia, radius of gyration; values of moments of inertia for simple geometrical objects (no derivation); statement of parallel and perpendicular axes theorems and their applications.

Practical: Use of vernier-caliper for volume of different shapes, screw-gauge, volume of irregular lamina, spherometer, parallelogram law of vectors, acceleration due to gravity, moment of inertia, co-efficient of friction, compound pendulum, Ketler's pendulum.

Phys. 92 Matter and Thermodynamics **4+1** **Sem. II**

Gravitation**:** Keplar's laws of planetary motion, the universal law of gravitation, acceleration due to gravity and its variation with altitude and depth, gravitational potential energy, gravitational potential;

escape velocity, orbital velocity of a satellite, geo-stationary satellites. Properties of Bulk Matter: elastic behaviour, stress-strain relationship, Hooke's law, Young's modulus, bulk modulus, shear, modulus of rigidity, poisson's-ratio, elastic energy, pressure due to a fluid column, Pascal's law and its applications (hydraulic lift and hydraulic brakes), effect of gravity on fluid pressure, viscosity, Stokes' law, terminal velocity, Reynold's number, streamline and turbulent flow, critical velocity; Bernoulli's theorem and its applications, surface energy and surface tension, angle of contact, excess of pressure, application of surface tension ideas to drops, bubbles and capillary rise; heat, temperature, thermal expansion; thermal expansion of solids, liquids and gases, anomalous expansion, specific heat capacity: Cp, Cv- calorimetry, change of state-latent heat, heat transfer-conduction, convection radiation and thermal conductivity, qualitative idea of blackbody radiation, Newton's law of cooling and Stefan's law, Wein's displacement law, green house effect. Thermodynamics: thermal equilibrium and definition of temperature (zeroth law of thermodynamics); heat, work and internal energy; first law of thermodynamics, isothermal and adiabatic processes; second law of thermodynamics, reversible and irreversible processes; heat engines and refrigerators. Behaviour of Perfect Gas and Kinetic theory: **e**quation of state of a perfect gas, work done on compressing a gas; kinetic theory of gases, assumptions, concept of pressure. Kinetic energy and temperature; rms, speed of gas molecules; degrees of freedom, law of equipartition of energy (statement only) and application to specific heat capacities of gases, concept of mean free path, avogadro's number. Oscillations and Waves: periodic motion, period, frequency, displacement as a function of time, periodic functions; simple harmonic motion (S.H.M) and its equation, phase, oscillations of a spring-restoring force and force constant; energy in S.H.M.- kinetic and potential energies; simple pendulum-derivation of expression for its time period; free, forced and damped oscillations (qualitative ideas only), resonance; wave motion; longitudinal and transverse waves, speed of wave motion, displacement-relation for a progressive wave, principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics, Beats, Doppler effect.

Practical: Gravitational pull of the earth, beam balance, Hook's law, resonance, sonometer, specific heat of the sand, coefficient of viscosity, Newton's law of cooling, surface tension, latent heat, Young's modulus.

Phys. 93 Electricity and Magnetism 4+1 Sem. I

Electrostatics: electric charges and their conservation, Coulomb's law-force between two point charges, forces between multiple charges; superposition principle and continuous charge distribution; electrical field, electric field due to a point charge, electric-field lines; electric dipole, electric field due to a dipole; torque on a dipole in uniform electric field; electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (Field inside and outside); electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges, equipotential surfaces, electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field. Conductors and Insulators: free charges and bound charges inside a conductor; dielectrics and electric polarisation, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor, Van de Graaf generator. Current Electricity: electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current; Ohm's law, electrical resistance, V-1 characteristics (linear and non linear), electrical energy and power, electrical resistivity and conductivity; carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistance; internal resistance of a cell, potential difference and emf of cell, combination of cells in series and in parallel; Kirchhoff's laws and simple applications, Wheatstone bridge, meter bridge, potentiometer-principle and its applications to measure potential difference and for comparing emf of two cells, measurement of internal resistance of a cell.

Magnetic Effects of Current and Magnetism: concept of magnetic field, Oersted's experiment, Biot-savart law and its application to current carrying circular loop; Ampere's law and its applications to infinitely long straight wire, straight and toroidal solenoids; Force on a moving charge in uniform magnetic and electric fields, cyclotron; force on a current-carrying conductor in a uniform magnetic field, force between two parallel current-carrying conductors, definition of ampere, torque experienced by a current loop in uniform magnetic field, moving coil galvanometers- its current sensitivity and conversion to ammeter and voltmeter, current loop as a magnetic dipole and its magnetic dipole moment, magnetic dipole moment of a revolving electron, magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis, torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; earth's magnetic field and magnetic elements, para-,dia-and ferro-magnetic substances with examples, electromagnets and factors affecting their strengths, permanent magnets. Electromagnetic Induction and Alternating Currents: electromagnetic induction, Faraday's laws, induced emf and current, Lenz's Law, Eddy currents: Self and mutual inductance; alternating current, peak and rms value of alternating current/voltage; reactance and impedances; LC oscillations, (qualitative treat ment only), LCR series circuit resonance, power in AC circuit, wattless current, AC generator and transformer. Electromagnetic Waves: need for displacement current, electromagnetic waves and their characteristics (qualitative ideas only), transverse nature of electromagnetic waves, electromagnetic spectrum (radio waves, radio-microwaves, infra-red, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.
Practical: Specific resistance of material using meter bridge, laws of combination (series/parallel) of resistance using meter bridge, compare the emf of two given primary cells, internal resistance of given primary cell, resistance of a galvanometer, frequency of the A.C. mains with a sonometer, Ohm’s law and to measure the unknown resistance, laws of combination (series/parallel) of resistance using Ohm’s law, magnetic line of forces, comparison of magnetic moment by tanA and tanB method.

Phys. 94 Optics, Nuclear Physics and Electronics 4+1 Sem. II

Optics: reflection of light, spherical mirrors, mirror formula, refraction of light, total internal reflection and its applications, optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lens-maker's formula; magnification, power of a lens, combination of thin lenses in contact, combination of lens and mirror, refraction and dispersion of light through a prism, scattering of light-blue colour of the sky and reddish appearance of the sun at sunrise and sunset. Optical Instruments: human eye, image formation and accommodation, correction of eye defects (myopia, hypermetropia) using lenses; microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers. Waves Optics: wave front and Huygens' Principle, reflection and refraction of plane wave at a plane surface using wave fronts; proof of laws of reflection and refraction using Huygens ‘Principle. Interference: Young's double hole experiment and expression for fringe width, coherent sources and sustained interference of light, diffraction due to a single slit, width of central maximum; resolving power of microscopes and astronomical telescopes; polarisation, plane polarised light-Brewster's law, uses of plane polarised light and Polaroids. Dual Nature of Matter and Radiation: photoelectric effect, Hertz and Lenard's observations'; Einstein's photoelectric equation, particle nature of light, matter waves-wave nature of particles, de Broglie relation, Davission-Germer experiment (experimental details should be omitted; only conclusion should be explained). Atoms and Nuclei: alpha-particle scattering experiment, Rutherford's model of atom, Bohr model, energy levels, hydrogen spectrum, composition and size of nucleus, atomic masses, isotopes, isobars, isotones, radioactivity- alpha, beta and gamma particles/rays and their properties, radioactive decay law, mass-energy relation, mass-defect, binding energy per nucleon and its variation with mass number, nuclear fission and fusion. Electronic Devices: energy bands in solids (qualitative idea only) conductor, insulators and semiconductors; semiconductor Diode-I-V characteristics in forward and reverse bias, diode as a rectifier, I-V characteristics of LED, photodiode, solar cell and Zener

diode, Zener diode as a voltage regulator, junction transistor, transistor action. Characteristics of a transistor: transistor as an amplifier (common emitter configuration) and oscillator, logic gates (OR, AND, NOT, NAND and NOR), transistor as a switch. Communication Systems: elements of a communication system (block diagram only), bandwidth of signals (speech, TV and digital data), bandwidth of transmission medium, propagation of electromagnetic waves in the atmosphere, sky and space wave propagation, need for modulation, production and detection of an amplitude modulated wave.
Practical: Concave mirror and find their focal length, lens-maker formula, focal length of a convex mirror using a convex lens, focal length of a concave lens using a convex lens, angle of minimum deviation for a given prism, I-V characteristic curve of a p-n junction, Zener diode characteristic, characteristics of a common-emitter npn or pnp transistor, reflective index of a glass slab using a traveling microscope, refractive index of a liquid by using concave mirror and convex lens.

Phys. 202 Fundamentals of Biophysics 2+1 Sem. II
Quantum mechanics- electronic structure of atoms, wave particle duality, wave length of de-Broglie waves, phase and group velocity. Some basic concepts of quantum mechanics. Schrodinger's wave equations. Particle in a box. Quantum mechanical tunneling. Ist and IInd law of thermodynamics. Enthalpy. Entropy- statistical and thermodynamic definition of entropy. Helmholtz free energy. Equilibrium thermodynamic. Near-equilibrium thermodynamic. Gibbs free energy, chemical potential. Thermodynamic analysis of membrane transport. Hydration of macromolecules- role of friction, diffusion, sedimentation. The ultracentrifuge. Viscosity. Rotational diffusion. Light scattering. Small angle x-ray scattering. Ultraviolet and visible spectroscopy. Circular dichroism (CD) and optical rotatory dispersion (ORD), fluorescence spectroscopy, infrared spectroscopy, Raman spectroscopy, electron spin resonance and NMR spectroscopy. Light microscopy. Electron optics-transmission electron microscope (TEM), scanning electron microscope (SEM). Preparation of the specimen for electron microscopy. Image reconstruction. Electron diffraction. Tunnelling electron microscope. Atomic force microscope. Crystals and symmetries, crystal systems, point group and space groups. Growth of crystals of biological molecules. X-ray diffraction.
Practical: Refractive index and dispersive power of the prism using spectrometer. Calibration of prism spectrometer. Newton's rings. Polarimeter. Diffraction grating. Resolving power of telescope and grating. Ostwald viscometer. Planck's constant using photovoltaic cell. Photospectrometer. Photoelectric effect. Stefan's constant. Thermal diffusivity in metals.

Phys. 203 Engineering Physics 2+1 Sem. I
Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization. Weiss molecular field theory and ferromagnetism. Curie-Weiss law.Wave particle quality, de-Broglie concept, uncertainty principle. Wave function. Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function. Bands in solids, velocity of Bloch's electron and effective mass. Distinction between metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, law of mass action. Determination of energy gap in semiconductors. Donors and acceptor levels. Superconductivity, critical magnetic field. Meissner effect. Isotope effect. Type-I and II superconductors, Josephson's effect DC and AC, Squids. Introduction to high T_c superconductors. Spontaneous and stimulated emission, Einstein A and B coefficients. Population inversion, He-Ne and Ruby lasers. Ammonia and Ruby masers. Holography-Note. Optical fiber. Physical structure. basic theory. Mode type, input output characteristics of optical fiber and applications. Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.
Practical: To find the frequency of A.C. supply using an electrical vibrator; To find the low resistance using Carey Foster bridge without calibrating the bridge wire; To determine dielectric constant of material using De Sauty's bridge; To determine the value of specific charge (e/m) for electrons by

helical method; To study the induced e.m.f. as a function of velocity of the magnet; To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil; To determine the energy band gap in a semiconductor using a p-n Junction diode; To determine the slit width from Fraunhofer diffraction pattern using laser beam; To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link; To study the phase relationships in L.R. circuit; To study LCR circuit; To study the variations of thermo emf of a copper-constantan thermo-couple with temperature; To find the wave length of light by prism.

Phys. 421 Modern Physics **2+1** **Sem. I**

Magnetic properties of materials. Orbital and spin magnetic moments of an electron. Bohr magnetron. Classical theory of dia and para magnetism. Special theory of relativity: lorentz transformation, length contraction, time dilation. Variation of mass. Einstein's mass-energy relationship. Photoelectric emission. photocell and photo-voltaic cell. Compton effect. Debye and Einstein models for specific heat of solids.

Practical: Determination of magnetic susceptibility. Dielectric constant. Hysteresis loss and e/m of electron. Michelson interferometer. Characteristics of Photocell.

Phys. 422 Atomic Spectra **2+0** **Sem. II**

Bohr and sommerfeld atom models. Vector model. Orbital magnetic moment and spin magnetic moment of the electron (classical theory). L-S and J-J couplings. Lande's 'g' splitting factor. Zeeman and Paschen- Back effect. Intensity and selection rules.

Postgraduate Courses

Phys. 501 Classical and Statistical Mechanics **3+0** **Sem. I**

Lagrange's equations of motion. Hamilton's Principle and Euler-Lagrange's differential equations of motion. Conservation theorems and symmetry properties. First integrals. Equivalent one dimensional problem and classification of orbits. Kepler's problem. Scattering in a central force field. Euler angles. Coriolis force. Motion of a rigid body. Inertia tensor and principal axis transformation. Euler equations. Hamilton's equations of motion. Canonical transformation. Infinitesimal contact transformation. Hamilton Jacobi equations. Action angle variables. Contact between statistics and thermodynamics. Classical ideal gas. Gibb's paradox. Microcanonical, canonical and grand canonical ensembles. Energy and density fluctuations. Density matrix. Statistics of ensembles. Properties of ideal Bose and Fermi gases. B.E. condensation. Cluster expansion for a classical gas. Ising model. Landau theory of phase transition and transport phenomenon.

Phys. 502 Physical Electronics **2+1** **Sem. I**

Bistable, mono-stable and astable multivibrators: operations, triggering and frequency of oscillation. Logic circuits: AND, OR, NOT, NAND, EX-OR gates. Boolean algebra: Demorgan's theorems. RS, JK and master slave JK flip flop. Memories. Seven segment display. Counting circuits. D/A and A/D converters. Operational Amplifier: frequency characteristics, applications as differential amplifier, adder, multiplier, differentiator, integrator, analog computations. Organization. CPVs. Evolution of 8085 microprocessor. Arithmetic logic unit. Instruction set of 8085 microprocessor. Writing assembly language programs. Opto-electronic devices. Fundamentals of optical communication. Amplitude modulation: generation of AM waves, demodulation of AM waves. DSBSC modulation. SSB modulation. Generation and detection of SSB waves. Frequency division multiplexing.

Practical: IC 723 as regulator. Multivibrators. Digital circuits. Operational amplifier as summing, subtracter and multiplier. Analogue computation. Comparators and switching circuits. Assembly language programming with 8085 microprocessor.

Phys. 503 Quantum Mechanics **3+0** **Sem. II**

Dirac's ket and bra notation. Non-degenerate and degenerate time-independent perturbation theories with application to Stark effect. Variational method with applications. WKB approximation. Time-dependent perturbation: transition probability constant and harmonic perturbations. Fermi golden rule. Scattering by spherically symmetric potential. Partial wave analysis. Optical theorem. Applications to square-well and rigid sphere potentials. Green's functions in scattering. Born approximation. Application to square well potential, screened Coulomb potential etc. Angular momentum and rotations. Eigen values and eigen functions of L and L^2. Electrons spin. Pauli spin matrices and spin wave functions. Raising and lowering operators. Matrix formulation of general angular momentum. Addition of angular momenta. Clebsch- Gorden coefficients. Exchange operators. Symmetric and antisymmetric wave functions. Heitler- London theory of hydrogen molecule. Helium atom. Scattering of identical particles. Klein-Gordon equations and hydrogen atom. Dirac equation and its plane wave solution. Significance of negative energy states. Existence of spin angular momentum. Electron in e.m. field. Dirac equation for particle in central field.

Phys. 504 Electrodynamics and Plasma Physics **3+0** **Sem. I**

Review of four-vector and Lorentz transformation in four-dimensional space. Electromagnetic field tensor in four dimensions and Maxwell's equations. Dual field tensor. Wave equation for vector and scalar potential and solution of retarded potential and Lienard-Wiechert potential. Electric and magnetic fields due to a uniformly moving charge and an accelerated charge. Linear and circular acceleration and angular distribution of power radiated. Bremsstrahlung and Cerenkov radiation. Reaction force of radiation. Motion of charged particles in electromagnetic field: uniform E and B fields. Non uniform fields. Diffusion across magnetic fields. Time varying E and B fields. Adiabatic invariance: first, second and third adiabatic invariants. Elementary concepts: derivation of moment equations from boltzmann equation. Plasma oscillations. Debye shielding. Plasma Parameters. Magnetoplasma. Plasma confinement.

Phys. 505 Solid State Physics **3+1** **Sem. II**

Many electron crystal hamiltonian. One-electron approximation. Bloch theorem. Nearly free electron theory. Tight binding theory. De Haas-van -Alphen effect. Cyclotron resonance. Magnetoresistance. Point defects: color centers, dislocations. Quantum theories of dia, para and ferromagnetism. Weiss molecular field theory of ferromagnetism. Ferrimagnetism and antiferromagnetism. Heisenberg exchange model. Spin waves and magnons, Electrostatic screening (Thomas-Fermi and random phase approximations). Quantum Hall effect. Lattice dynamics of simple metals: monoatomic and diatomic linear lattice. Debye-Waller factor. Inelastic neutron scattering. Thermal expansion and thermal conductivity. Nano structured material and their properties. Methods of synthesis of nano materials. characteristics of nanomaterials. Special carbon solids: fullerences and nano tubes. Electronic properties of nanotubes.

Practical: Susceptibility of liquids and solids. Hysteresis loss. Electron spin resonance. Four probe method. Hall effect. Dispersion relations with lattice dynamics kit. Measurement of dielectric constant. Microwave experiment. Curie temperature of ferrimagnetics.

Phys. 506 Nuclear Physics **3+1** **Sem. II**

Deutron problem. Alpha spectra and Gamow theory. Nuclear radiation detectors: gas counters, solid state detectors and scintillation counters. High energy particle detector. Interaction of neutrons with matter and biological materials. Fermi theory of beta decay. Nuclear models. Nuclear parameters on the basis of models. Stripping and pick up reactions. Breit Wigner's formula. Elements of heavy ions induced reactions. Classification of fundamental particles. Gellman Nishijima formula. quark model. Parity conservation. Charge independence. Time reversal invariance. CPT theorem. spin of pion, τ-θ puzzle.

Practical: Studies of operating voltage. Window width and dead time of G.M. counter. Attenuation

studies of beta particles in aluminium. End point energy of beta rays. Calibration of gamma ray spectrometer. Resolving power of a gamma ray spectrometer. Half value thickness of aluminum. iron and lead. Inverse square law.

Phys. 507 Nuclear Techniques in Agriculture 2+1 Sem. II

Natural, artificial and induced radioactivity. Units of radioactivity. Interactions of nuclear radiations with matter. Detection and measurement of nuclear radiations. GM Counter. Solid and liquid scintillation counters. Characteristics of alpha, beta and gamma radiations. Nuclear technique. Crop improvement. Adaptability of fertilizers by the plants using tracer techniques. Interaction of neutrons with matter and biological materials. Nuclear techniques for determining moisture content of Soils. Determination of nitrogen and protein contents of seeds using nuclear technique. Seed oil measurement using NMR technique. Water dating. Application of Mossbauer spectroscopy in agriculture. Radiation hormesis. Radiation induced phenomena: food irradiation and radiation protection. Radioactive waste disposals.

Practical: Half life determination. Neutron activation based experiments. Attenuation studies of beta particle in plant leaves. Isotope uptake by plants. Statistical fluctuations.

Phys. 508 Material Science 2+1 Sem. I

X-ray diffraction. Crystal structure: determination and methods. Polymers: classification, structure and crystallinity. Phase diagrams: the phase rule, single component system and binary phase diagrams. Micro-structural changes during cooling. The lever rule. Nucleation and growth. Nucleation kinetics. The glass transition, recovery, re-crystallization and grain growth. Elastic, inelastic and viscoelastic behaviour of materials. Dielectric and superconducting materials.

Practical: Cooling curve of binary alloy. Mechanical behaviour of elastomers. Electrical conductivity of ionic solids. Dielectric constant and dielectric loss. Susceptibility. Hystersis loop.

Phys. 509 Radiation Physics 2+1 Sem. II

Basic physical processes in radiation detection. Gas-filled ionization detectors. Semiconductor detectors. Scintillation detectors. Electronics for detector signal processing. Radiation measurement techniques. Measurement of strength of source, half-life, energy, spin, dipole and quadrupole moment of nuclei. Interaction of radiation with living matter. Radiation health protection.

Practical: Study of characteristics of GM counter. Half-life of a radioactive source. Statistical fluctuations of data on GM counter. Energy resolution of a scintillation spectrometer. Verification of inverse square law. Estimation of neutral flux.

Phys. 510 Solid State Devices 2+1 Sem. I

Regulated power supplies. CRO. Electronic instruments for measurements of voltage, current resistance and other circuit parameters. Signal generators. Transducers. pH meter. Conductivity meters, Dipolometer.

Practical: Study of CRO and a multimeter as a measuring device. Study of regulated power supply. Astable multivibrator. Logic gates.

Phys. 511 Agricultural Physics 2+0 Sem. II

Thermal properties of soil constituents. Heat flux in soil Fourier laws. Movement of heat in the soil. Water flux in soil and plant systems. Movement of water in soil, evaporation, humidity. Aerodynamics in soil plant system. Physical force fields in soil plant system. Radiation and energy balance of atmosphere and earth surface. Remote sensing system. Sensors. Resolution and data analysis. Use of ratio isotopes in agriculture.

Phys. 512 Principles of Remote Sensing and its Applications in Agriculture 2+0 Sem. I

Basic components of remote sensing: signals, sensors and sensing systems. Active and passive remote sensing. Characteristics of electromagnetic radiation and its interaction with matter. Spectral features of earth's surface. remote sensors in visible, infrared and microwave regions. Imaging and non-imaging systems. Framing and scanning systems. Resolution of sensors. Sensors platforms: their launching and maintenance.
Data acquisition system: data processing, storage and dissemination. Digital image processing and information. Information extraction. Microwave remote sensing. Visual and digital image interpretation. Introduction to GIS and GPS digital techniques for crop stress detection. Soil moisture assessment. Inventory of ground water and satellite measurement of surface soil moisture and temperature. Drought monitoring. Monitoring of crop disease and pest infection. Soil resource inventory: land use/land cover mapping and planning and integrated watershed development. Crop yield modeling and crop production forecasting.

Phys. 513 Principles of Physical Techniques in Agriculture 2+1 Sem. I
Principle of measurements: laboratory, field and regional scales. Principles of optical and polarized microscopes: reflection, transmission and absorption in relation to properties of object. Colorimetric techniques: single and double beam instruments, spectrophotometry. Beer and Lambert law. Fluroscence. Raman spectra. Sensors and transducers. Principle of leaf area meter. Canopy analyzer. Quantum sensor. Spectro- radiometer. Laser land leveler. Photosynthetic system analyzer for determination of plant water and photosynthetic parameters. Principle of infrared thermometry. Emissivity laws. Characteristics of agricultural materials. Principle of X-ray and its applications in clay mineralogy; small angle scattering. Principle and applications of electron microscopes. Transmission and scanning electron microscopes. Confocal microscope and its applications. Atomic absorption spectroscopy: principle, detection limits and sensitivity. Nuclear techniques: detection and measurements of charged particles, radiation monitoring instruments. Radiation hazards evaluation and protection. Tracer methodology: isotopes and their applications in agriculture. Gamma irradiation for genetic variability. NMR, mass spectrometer: principle and applications.
Practical: Discharge of electricity through gases. Ionization current measurements. Photoelectric effect and measurements. Geiger Muller counter-quenching time. Thickness measurement of thin films/ foils/paper sheets. Half-life determination. Tracer applications of artificial radio nuclides. Multi-channel analyzer.

Phys. 601 Current Topics in Physics 3+0 Sem. I
Quauntum mechanical treatment of super conductivity: electron-phonon effective interaction. Model interaction. Cooper pair. Fermi-Liquid theory. Pair Amplitude. BCS ground state. Critical magnetic field. Energy gap. Quasi-particle excitation: thermodynamics, Josephson's tunneling. Quantum Hall effect. Landau Levels. The role of disorder. Currents at the edge. Laughlin liquid. Quantum size effect. Nano particles and nanotechnology. Principles and applications of electron microscopes. Transmission and scanning electron microscopes.

Phys. 602 Advanced Topics in Quantum Mechanics 3+0 Sem. I
Discussion of topics like variational method. Quantum field theory. Quantization of wave fields. Quantization of non-relativistics Schrodinger equation. Quantization of electromagnetic field energy and momentum. Boson and Fermion fields and their applications. Feynman diagrams. Dirac propagator. Canonical quantization. General formulation. Scalar field. Charged scalar field. Feynman propagation recovered. Quantized radiation field.

Phys. 603 Advanced Topics in Solid State Physics I 3+0 Sem. II
Discussion of topics like electrostatic screening in metals. Friedel oscillation. optical properties of solids and De Hass-Van-alphan effect. Born-Von-Karman theory. Non- crystalline solids: diffraction pattern, glasses, amorphous ferromagnets and amorphous semiconductors. Low energy excitation

in amorphous solids. Liquid crystals: classification, orientation order, intermolecular forces, magnetic effects, optical properties
and applications. Polymers: effect of temperature, mechanical properties and electrical properties.

Phys. 604 Advanced Topics in Nuclear Physics I3+0 Sem. II
Measurement of nuclear parameters. Electron, positron, neutron and heavy charged particles interaction with matter and super heavy nuclei. Acceleration of charged particles. Artificial elements. Accelerators: dc machines, linear accelerator, cyclotron, betatron, electron and proton synchrotron. Quarks and Leptons: elementary properties, weak interaction of b and t quarks. Grand unified theories.

Phys. 605 Advanced Topics in Solid State Physics II 3+0 Sem. I
Magnons in magnetic materials. Boltzmann transport equation. Fiber optics. Many body interactions. Super paramagnetism. Collective magnetic oscillations. Exchange bias effect. Magnetic quantum tunneling effect. Magnetoresistance and magnetic nano particles. Plasmons. Polaritons. Dielectric function of the electron gas. Electrostatic screening. LST relations. Electron-electron interaction. Electron-phonon interaction.

Phys. 606 Advanced Topics in Nuclear Physics II 3+0 Sem. II
Acceleration of charged particles: recent advances in accelerator-based nuclear reactions. Radiation dosimetry of photon and electron beams. Neutron physics: production and detection of neutrons. Interaction of neutrons with matter in bulk. Thermal neutrons: diffusion of thermal neutrons and cross- section for neutron induced reactions. Nuclear energy sources. Problems and concepts of isotope separation. Neutron activation analysis: principle, instrumentation, source and applications.

Phys. 591 Seminar

Phys. 600 Master's Research

Phys. 700 Ph.D. Research

MICROBIOLOGY

PROGRAMMES

M.Sc.

Ph.D.

Five Year Integrated M.Sc. (Hons)

COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Industrial Microbiology, Microbial Genetics, Soil Microbiology, Food Microbiology.
Required Courses	Micro. 501, Micro. 502, Micro. 503, Micro. 504, Micro. 505.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem
Minor Fields	Biochemistry, Plant Breeding and Genetics, Soil Science, Plant Pathology, Food Science and Technology, Biotechnology or any other as approved by the Dean, Postgraduate studies
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization	Industrial Microbiology, Microbial Genetics, Soil Microbiology, Food Microbiology.
Required Courses	Micro. 601, Micro. 602
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Fields	Biochemistry, Plant Breeding and Genetics, Soil Science, Plant Pathology, Food Science and Technology, Biotechnology or any other as approved by the Dean, Postgraduate studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

Five Year Integrated M.Sc. (Hons)

Field of Specialization	Industrial Microbiology, Microbial Genetics, Soil Microbiology, Food Microbiology
Required Courses	All courses listed for Semester I-VI (P-___*) and Micro. 501, Micro. 502, Micro. 503, Micro. 504, Micro. 505.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem
Minor Fields	Biochemistry, Plant Breeding and Genetics, Soil Science, Plant Pathology, Food Science and Technology, Biotechnology or any other as approved by the Dean, Postgraduate studies.
Deficiency Courses	As recommended by the student’s Advisory Committee and approved by the Dean, Postgraduate Studies

* Page number according to new RBI.

DESCRIPTION OF COURSE CONTENTS

Undergraduate courses/Integrated M.Sc. (Hons)

Micro. 102 Elementary Microbiology **2+1** **Sem. I & II**

History of Microbiology and its applied areas. Introduction to prokaryotic and eukaryotic cell. Major groups of prokaryotes – Actinomycetes, Cyanobacteria, Archaebacteria, Rickettsias and Chlamydia. Major groups of eukaryotes- fungi, algae and protozoa. Bacterial growth. Metabolism in bacteria - ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation. Viruses, Bacteriophages - structure and properties, lytic and lysogenic cycles. viriods, prions. Bacterial genetics- Genetic recombination, transformation, conjugation and transduction, plasmids, transposons. Carbon, Nitrogen, Phosphorus and Sulphur cycles. Role of microbial groups in soil fertility and crop production, biofertilizers, biological nitrogen fixation - symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare- silage production, biopesticides, biofuel / biogas production and biodegradation of agro-waste. Edible and poisonous mushrooms. Cultivation technology of mushrooms. Microbiology of water and food.

Practical: Introduction to microbiology laboratory and its equipments. Microscopy, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and preparation. Enumeration of microbial population in soil - bacteria, fungi and actinomycetes. Methods of isolation and purification of Rhizobium from legume root nodule, Azotobacter from soil, Azospirillum from roots and BGA from soil. Staining and microscopic examination of microbes. Micrometry.

Micro. 103 General Microbiology **2+1** **Sem. I**

Evolution and scope of microbiology. History of microbiology. Microbial classification, nomenclature and identification. Taxonomic groups. General methods of classifying bacteria. Microscopy and microscopes: Smears and staining. Morphology and fine structure of bacteria. Cultivation of bacteria, nutritional requirements. Nutritional classification of bacteria; Phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Bacteriological media, Growth of bacteria, Reproduction of bacteria; Introduction to fungi, algae and protozoa and virus, Microbiology of water and food Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport. Metabolism in bacteria –ATP generation Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, mutagenesis; Mutation rate, repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants; Destruction of microorganisms: Physical agents and chemical agents; Chemotherapeutic agents and chemotherapy; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

Practical: Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, Gram staining, negative staining, capsule-staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

Micro. 104 Food Microbiology **2+1** **Sem. II**

Importance and significance of microbes in food science. Microbial spoilage of foods. Factors affecting kinds, numbers, growth and survival of microorganisms in foods. Intrinsic factors- pH,

water activity, nutrients etc. Extrinsic factors-relative humidity, temperature, gaseous atmosphere. Chemical changes caused by microorganisms. Contamination of foods. Sources of contamination. Genera of bacteria. Maintenance of anaerobic conditions. Asepsis, removal of microorganisms. Intermediate moisture foods. Microbiology of milk and milk products, meat and meat products, fish and other sea foods, poultry and eggs, fruits and vegetables, cereal and cereal products, sugar and sugar products, salts, spices and canned foods. Shelf life-Calculation of shelf life, shelf life requirements, deteriorative reactions. Food borne intoxications, infections, toxicity and symptoms. Food borne viruses- Polio, Hepatitis A & E, noroviruses, rota viruses, prion diseases, infections, toxicity and symptoms, types of food involved, chemical properties, environmental conditions.

Practical: Microbial examination of bacteria and molds from foods. Isolation, identification and confirmation of microbes in milk and milk products, meat and meat products, fish and other sea foods, poultry and eggs, fruits and vegetables, cereals and cereal products, sugar and sugar products, salts, spices and canned food. Determination of thermal death time. Detection of indicator organisms (Coliform/Enterococcus) in water by MPN method. Determination and enumeration of food borne pathogens from food samples.

Micro. 201 Microbial Genetics **2+1 Sem. I**

Microorganisms as tools for genetic studies. Genetic variability in microorganisms. Genetic analysis of representative groups of bacteria, fungi and viruses. Random and tetrad spore analysis. Recombination and chromosomal mapping. Complementation-intergenic and intragenic. Transfer of genetic material in bacteria- conjugation, transformation and transduction. Bacterial plasmids - structure, life cycle, mode of infection and role in genetic engineering. Genetics of bacteriophage, fine structure of gene, life cycle, mode of infection of T4, lambda and M13. Mutation - types, mutagens, DNA damage and repair. Transposable elements. Lac operon. Concept and application of recombinant DNA technology. Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health.

Practical - Conjugation and transformation in bacteria. Spontaneous and auxotrophic mutation. Chemical and UV mutagenesis in fungi and bacteria. Complementation in fungi. Identification of mutants using replica plating technique. Isolation of genomic DNA from E. coli. Isolation, curing and identification of plasmid by electrophoresis / antibiotic plates.

Micro. 202 Introduction to Microbiology **3+0 Sem. II**

Introduction to Microbiology and its scope. Discovery of microorganisms, Microscopy, Brief description of major groups of eukaryotes and prokaryotes. Biology of viruses. Use of microscope and other laboratory equipments. Methods in microbiology and cultivation of microorganisms. Importance of microorganisms in agriculture, organic matter decomposition, cycles of matter in nature. Biological nitrogen fixation. Role of microorganisms in food, dairy and fermentation industries, biogas and waste water treatment. Microorganisms as food. Single Cell Protein. Microorganisms as pathogens.

Micro. 203 Basic Bacteriology **2+0 Sem. I**

Bacterial taxonomy, cell structure and organization of bacterial cell, cell wall, periplasm, outer membranes in Gram-ve bacteria, cell surface extensions, motility, role of pili in adhesion, motility, DNA exchange, capsule, spore, heterocysts, Archaebacteria. Unique structures in Eukaryotes, mitochondria and plastids, economic importance of bacteria.

Micro. 204 Basic Mycology and Phycology **3+0 Sem. I**

Isolation, distribution, thallus organization, cell structure, nutrition. Sexual and asexual reproduction, spore types, heterothallism and parasexuality in fungi. Classification of fungi and salient features of different classes. Economic importance of fungi. Mushroom cultivation, SCP.

Industrially important fungi - Aspergillus sp, Penicillium sp, their structure and growth characteristics. Role of fungi in antibiotic and enzyme, Solid State Fermentation. Fungal diseases of plants. Introduction of algae,-general classification, morphology and reproduction, photosynthetic apparatus, nitrogen fixation by Cyanobacteria, economic importance of algae.

Micro. 205 Basic Virology 2+0 Sem. II

General properties and classification of viruses. Structure and replication of viruses. Bacterial; virus- structure of bacteriophage, lytic life cycle and lysogeny. Plant viruses, common plant viral diseases-TMV. Satelite virus, viroid. Animal viruses-Rinder pest, Ranikhet, FMD virus-Herpes, HIV, Hepititis. Viral vaccines, prions.

Micro. 207 Principles of Food Microbiology 2+1 Sem. I

Basic aspects and scope of food microbiology. Intrinsic and extrinsic factors affecting microbial growth in foods. Microbial spoilage of fruits, fruit juices, vegetables, meat, poultry, sea foods, carbonated soft drinks, canned foods and cereals. Chemical changes caused by microorganisms and control of spoilage. Food preservation - physical methods, chemical preservatives, natural antimicrobial compounds and biology based preservation system. Control of microorganisms by asepsis, water activity, drying, preservatives, use of low and high temperature, radiation and pressure. Microbial contamination, spoilage and prevention of milk and milk products, fruits and vegetables, meat and meat products, fish and other sea foods, poultry and eggs, cereal and cereal products, sugar and sugar products, salts and spices.

Practical - General laboratory practices in microbiology laboratory. Equipment used in food microbiology laboratory. Aseptic and sterilization methods. Preparation of media. Isolation and morphological identification of microorganisms. Isolation of molds from foods. Microbial analysis of vegetable and fruits, meat and meat products, fish and other sea foods, eggs and poultry, milk and milk products, cereal and cereal products, sugar, salts and spices and water.

Micro. 303 / Biotech. 304 Introduction to Industrial Biotechnology 2+1 Sem. II

Microbial products; Acids, organic solvents, vitamins, enzymes and biodegradable plastics. Microbial technology; substrates. Upstream and downstream processing, Biotransformation, Fermenters, BOD and COD treatments and disposal of effluents. Hybridization technology and production of vaccines, Production of plant secondary metabolites through cell and hairy root cultures. Concepts of industrial fermentation- batch and continuous, production of biopharmaceuticals, Immobilization techniques.

Practical: Isolation, characterization and maintenance of biotechnologically important micro-organisms. Use of laboratory and industrial scale shaker. Batch and continuous cultures. Use of fermentors. Raising somatic cell cultures. Hairy root cultures.

Micro. 304 Introduction to Applied Microbiology 3+0 Sem. I

Important disciplines of applied microbiology. Importance and applications of microorganisms in food, dairy and industry. Food spoilage and food borne diseases. Food preservation and sanitation. Microbiology of milk and milk products. Industrial fermentation of alcohol, alcoholic beverages and enzymes. Brief account of agriculturally important microorganisms - biofertilizers, biopesticides and bioremediation.

Micro. 305 Basic Experiments in Microbiology 0+3 Sem. II

Microscopy. Examination of different types of bacteria, fungi and other microorganisms, motility. Media preparation, isolation, cultivation and purification of microorganisms from air, soil and water. Principle and working - autoclave, laminar flow bench, hot air oven and other commonly used laboratory equipments. Measure of bacterial cell size, DMC using haemocytometer. Sterilization techniques.

Micro. 306 Fundamentals of Food and Dairy Microbiology 3+1 Sem. I

Introduction and importance of food and dairy microbiology. Food spoilage. Food preservation by physical and chemical means. Microbiology of cereals, meat, poultry, egg, fruits and vegetables, salt, sugar. Fermented foods-bread, malt beverages. Role of microorganisms in fermented milk products - butter and cheese, etc. Microbial enzymes in food processing. Pathogenic bacteria in milk and milk products and processed foods. Food poisoning and its control.

Practical: Microbiological examination of various foods-fruits and vegetables, meat, milk and milk products- enumeration. Dye reduction test for assessing quality of milk. Starter culture-preparation, evaluation and application. Microbiological analysis of water.

Micro. 307 Bacterial Genetics 3+0 Sem. I

Bacteria as tool for genetic studies, nature of genetic material, DNA structure, function, replication and synthesis. DNA damage and repair. RNA - types and functions. Mutations and their chemical basis, mutagenesis, spontaneous and induced mutations, reversion and suppression of mutants. Bacterial recombination- transformation, transduction and conjugation. Bacterial plasmids, fertility factors, resistance factors, transposable elements and insertion sequences. Role of genetic engineering in improving bacterial strains.

Micro. 308 Fundamentals of Industrial Microbiology 2+1 Sem. II

History of industrial microbiology. Primary and secondary metabolites produced by the microorganisms. Screening of microorganisms. Preservation of microorganisms. Organizations involved in microbiological work. Fermentation media, industrial sterilization, thermal death time, media heat sterilization, continuous sterilization, design of sterilization, deterministic and probabilistic approach in designing of sterilizing equipments, sterilization charts. Fermentor - components, parts, peripheral parts and accessories. Types of fermentors. Types of fermentations. Microbial production of industrially important secondary metabolites. Probiotics - role of beneficial organisms in fermented foods. Production of bacteriocins, nisin and microbial enzymes. Downstream processing for extraction; purification; concentration. Product recovery - foaming, filtration, centrifugation, cell disruption methods - mechanical and non-mechanical methods.

Practical: Isolation and screening of citric acid/ amylase/ protease /antibiotic and biocolours producing microbes. Production, purification and estimation of citric acid/lactic acid/ acetic acid. Standardization of fermentation conditions for higher yields of citric acid. Production, purification, estimation of beer/ ethanol. Assay of fungal amylases/proteases/Lipase, Assay of Nisin. Production of single cell proteins and mushrooms. Starter activity of Baker's yeast.

Micro. 401 Practicals in Microbiology 0+2 Sem. II

Microscopy-phase contrast, fluorescent and electron microscope. Morphological, physiological and biochemical characterization of microorganisms. Maintenance and preservation of cultures. Growth curve of bacteria and fungi. Measurement of growth, microbial sensitivity. Production of microbial biomass and protein estimation. Replica plating technique. Composting of organic residues. Principles and working of pH meter, Spectrophotometer and electrophoresis.

Micro. 421 Fundamentals of Microbiology 2+1 Sem. II

History of microbiology. Nature and properties of prokaryotic and eukaryotic microorganisms. Brief discussion on taxonomy of microorganisms. Biology of viruses. Cultivation and maintenance of microorganisms. Bacterial growth and effect of environment on growth of microorganisms. Dormancy in microorganisms. Role of microorganisms in food, dairy, fermentation and agriculture.

Practical: Isolation of microorganism and their microscopic examination. Staining procedure-

simple, differential, negative, capsule and spore. Sterilization and preparation of culture media, enumeration of microorganisms and their identification.

Micro. 426 Fundamentals of Soil Microbiology 2+1 Sem. II

Soil as an environment for microorganisms and physico-chemical properties of soil. Occurrence of different groups of microorganisms in soil and their importance in agriculture, Biogeochemical cycles - C, N, P and S-cycles. Biological nitrogen fixation, its significance in agriculture. Microbiology of organic matter decomposition and humus formation. Phosphorus solubilization by microorganisms, mycorrhizae and its types. Pesticides and their effects on soil microflora. Biofertilizers and their use in agriculture. Practical : Isolation, enumeration and characterization of different groups of soil microorganisms. Isolation and identification of symbiotic, non-symbiotic and P-solubilizing microorganisms. Isolation of pesticide resistant soil bacteria. Staining of VA mycorrhizae.

Micro. 427 Fundamentals of Environmental Microbiology 2+1 Sem. II

Microbial diversity-habitat and environment selection factors. Ecological niches. Survival of microorganisms- competition, adaptation. Intramicrobial and extramicrobial relationship-symbiotic relationship-lichens, rhizobium-legume, mycorrhizas, microbial-rumen, microbial insects. Microbial transformations - cycles of nature, biochemistry and energy production. Life in extreme environment - Archaebacteria-cell structure, biochemical and molecular adaptation. Enrichment of microorganisms from different environments. Microbial role in pollution-concept of BOD and COD, sewage and solid waste disposal, pesticide and xenobiotics. Drinking water BIS standards. Application of extermophiles, biogas production, bioplastics, composting, bioleaching, bioscrubbing, etc.

Practical: Enrichment of microorganisms from polluted environment-air, water, sewage etc. to study microbial diversity. Microbial relationship in situ condition. Winogradsky column. Determination of BOD and COD. Analysis of drinking water-biochemical and microbiological parameters. Growth characteristics of extreme microbes-halophiles and thermophiles. Biogas production in laboratory.

Micro. 428 Fundamentals of Clinical Microbiology 2+1 Sem. II

Host parasite relationship of infectious diseases, determinants of infectious diseases, attributes of pathogens and offending host-physical, chemical barriers and biological barriers, specific and non specific immune defense mechanisms of host, autoimmune diseases and allergic reactions. Introduction to pathogenic microbiology, epidemiology of infectious diseases, infectious disease cycle, transmission of infectious agents, surveillance, recognition, study and control of epidemics and nosocomial infection. Viral diseases, Characteristics of causal agents and disease control of selected diseases such as influenza, measles, yellow fever, rabies, poliomyelitis and AIDS. Microbial diseases of humans caused by Chlamydiae, rickettsiae, Gram positive and Gram negative organisms, human mycotic and parasitic protozoan infections.

Practical: Peripheral blood examination. Microscopy and morphological examination of important pathogens. Microbiological examination of sputum, urine, stool, wounds and pus. Isolation of bacteria and antibiotic sensitivity test.

Postgraduate Courses

Micro. 501 Principles of Microbiology 3+1 Sem. I

Introduction and scope of microbiology. Development of Microbiology in the 18^{th} and 19^{th} century. Sterilization principles and methods- Dry heat and wet heat, chemical etc. Methods of isolation, identification, maintenance and preservation of microorganisms. Systematic position of microorganisms. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea.

Classification of prokaryotes - Basic principles and techniques used in bacterial classification. Evolutionary relationship among prokaryotes Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tanericutes 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 humans and animals. Nutrition, growth and energy generation in bacteria. Sporogenesis. Microbial ecology, role of microorganisms in cycles of matter and biotechnology. Immune response and immunization.
Practical: Stainings-simple, differential, negative, capsule and flagella. Methods of isolation of microorganisms from different environments (air, water, soil, milk and food). Enrichment culture of asymbiotic and symbiotic nitrogen fixing bacteria. 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 3+1 Sem. II
Structure, function, biosynthesis and assembly of various cellular components of prokaryotes, archaebacteria and fungi. Transport of solutes across the membrane. Cell membrane structure, permeability and mechanisms of nutrient transport. Microbial growth-mathematical model, effects of physical and chemical factors, continuous culture, diauxic growth. Method of growth measurement. Cell cycle and cell division. Bioenergetics -carbohydrate utilization via EMP, HMP, ED, TCA pathways, Aerobic and anaerobic respiration. Fermentative metabolism- ethanol, lactic acid, butanol, acetone and mixed acid fermentation. Fermentation of nitrogenous organic compounds and phototrophic bacteria. Biosynthesis of macromolecules- nucleotides, proteins, lipid and carbohydrates, their assembly into cellular components. Regulation of microbial metabolism, induction and repression of enzymes. Effect of chemicals and other environmental factors on growth. Morphogenesis and cellular differentiation in bacteria. Important metabolic patterns in photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs. Bacterial endospores-types, morphology, biochemistry and regulation of formation and germination.
Practical: Use of simple techniques in laboratory (colorimetery, centrifugation electrophoresis, GLC). Growth measurements in bacteria and fungi-optical density, viable cell count, biomass, linear growth. Physical and chemical factors affecting microbial growth. Demonstration of thermo, meso, and psychrophilic micro-organisms. Diauxic growth in bacteria. Study of bacterial types and factors affecting germination. Production and testing of inducible enzymes in bacteria. Studies on protoplast formation.

Micro. 503 Microbial Genetics 3+1 Sem. I
Prokaryotic, eukaryotic and viral genome. Concept of biochemical and microbial genetics. Nature of genetic material of cellular and acellular microorganisms, Replication of Eukaryotic, Prokaryotic and Viral DNA. Spontaneous and induced mutations and molecular basis of mutagenesis and DNA repair. Modes of gene transfer in bacteria - transformation, transduction and conjugation, application of these processes in gene mapping. Bacterial plasmids, types of plasmids, insertion sequences and transposons. Recombination and complementation in bacteria. Genetic organization of phage genome, phage mutations and fine structure analysis of gene. Recombinant DNA technology/ methodology and applications. Fungal genetics. Concept of genomics and proteomics. Strain improvement of industrially important microorganisms. Gene cloning and gene sequencing. Impact of gene cloning on human welfare. Regulation of gene expression. Genetic basis of cancer and cell death.
Practical: Genetic variability, fluctuation test and replica plating. Induced mutagenesis. Plasmid curing, purification of plasmid DNA, electroporation/conjugation. Agarose gel electrophoresis, DNA amplification by PCR.

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

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

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

Micro. 505 Laboratory Techniques in Microbiology 0+2 Sem. I

Microscopy - parts of simple and compound microscopes, examination of microbial cultures. Staining of bacterial cells - simple and gram. Preparation and sterilization of culture media - general purpose, selective and differential. Inoculation and incubation techniques. Isolation and enumeration of micro- organisms from soil and food products. Morphological and biochemical characterization. Measurement of bacterial cell size and haemocytometry. Maintenance and preservation of microbial cultures. Growth curve for bacteria and fungi. Sensitivity of microbial cultures to different antibiotics. Production of microbial biomass and protein estimation. Principles and techniques of spectrophotometry, chromatography, pH meter, electrophoresis, centrifugation, GLC, HPLC, Lab. Scale fermenter and Thermocycler.

Micro. 506 Food and Dairy Microbiology 2+1 Sem. I

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. Enzymes from microorganisms. 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. Synbiotic foods. Advanced techniques in detecting food-borne pathogens and toxins. Predictive Microbiology. Hurdle technology and Hazard Analysis and 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 Soil Microbiology 2+1 Sem. II

Landmarks in the history of soil microbiology. Soil biota, Soil microbial ecology. Biotic factors in soil development. Influence of soil and environmental factors i.e. pH, temperature and organic matter and agronomic practices on soil microflora. Different types of microorganisms in soils, Soil microbial biomass; Microbial interactions; unculturable soil biota. Microbiology and biochemistry of root-soil interface; Phyllosphere, Biofertilizers; Soil enzyme activities and their importance.

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and antimicrobials. Biochemical composition and biodegradation of soil organic matter and crop residues. Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures.
Practical:Determination of soil microbial population; Soil microbial biomass; Decomposition studies in soil. 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. Detection of hydrogen uptake system in Rhizobium.

Micro. 508 Clinical Microbiology 2+1 Sem. I
Infection, Biological properties of etiological agents, pathogenicity, laboratory diagnosis, epidemiology, immunity and prophylaxis against diseases. Clinical manifestation, gross and histopathological changes in the tissues. Methods of transmission of infections. Factors predisposing to microbial pathogenicity. Immunoglobulin diversity, affinity of antigen antibody interaction and its biological significance. Molecular basis of immunogenicity and antigenicity. Human diseases and etiological agents *Staphylococcus, Streptococcus, Pneumococcus, Corynebacterium, Clostrdium, Enterobacteriacae, Vibrio, Pseudomonas, Yersinia, Campylobacter, Spirochetes, Bordetella, Pasteurella, Mycobacterium*. Bacterial diseases transmitted by direct contact, wound infections, food and water borne infections. Important diseases caused by Actinomycetes, viruses, protozoa. Cutaneous and Systematic disease caused by fungi. Use of modern vaccines/non-conventional vaccines.
Practical: Handling of laboratory animals, blood sampling, introduction of culture method biochemical identification and serological methods. Microbiological examination of sputum, nasal discharge, urine, stool, wounds and pus, etc. Serological diagnosis and typing of pathogenic bacteria. Gel precipitation test for bacterial toxins.

Micro. 509 Biofertilizer Technology 2+1 Sem. I
Biofertilizers, their types and importance. Nitrogen fixing biofertilizers and their use. Mechanism of phosphorous solubilization by phosphobacteria and mobilization by VAM fungi. Plant growth promoting rhizobacteria, biocontrol microbial inoculants. Different agriculturally important microorganisms for recycling of organic waste and composting, biomediators and other related microbes. Selection of agriculturally important beneficial microorganisms, establishments, competitiveness, crop productivity, soil and plant health. Biofertilizer inoculation and microbial communities in the soil. Studies on inoculum preparation. Mass multiplication of biofertilizers and types of carrier materials. Studies on quality control of biofertilizers. Constraints of biofertilizer development. BIS standards of biofertilizers.
Practical: Isolation of nitrogen fixing and phosphate solubilizing microorganisms. Isolation and purification of Azotobacter and Azospirillum. Enumeration of spores and inoculum production of VAM fungi. Inoculum preparation and mass multiplication techniques. Population dynamics in broth and carrier materials during storage.

Micro. 510 Biology and Cultivation of Edible Fungi 2+1 Sem. II
History, importance, classification and characterization of edible fungi. Food value and medicinal importance of mushrooms. Nutritional, physiological and life cycle studies of *Agaricus, Volvariella, Calocybe, Pleurotus and Lentinus*. Sexuality and breeding of commonly cultivated edible taxa, strain improvement studies through conventional/non-conventional techniques. Substrate preparation and cultivation techniques of *Agaricus, Volvariella, Pleurotus*, and speciality mushrooms (*Auricularia, Lentinus* and *Calocybe*). Common pests, diseases and nematodes of mushrooms. Post harvest technology for improvement in shelf life of mushrooms- washing, steeping, blanching, drying and packaging.
Practical: Micro/macroscopic characteristics of important genera. Preparation and maintenance of

spore and tissue cultures and spawn making. Compost preparation by long and short method and cultivation of important genera (*Agaricus, Calocybe indica, Pleurotus, Volvariella, Auricularia* and *Lentinus edodes*). Production, extraction and estimation of extracellular enzymes. Isolation of single spore isolates (SSI's) and in vivo somatic hybridization for mushroom strain improvement. Visit to a commercial mushroom growing unit.

Micro. 601 Current Topics in Microbiology 3+0 Sem. II

Molecular biology of plant and animal viruses, their infection, expression for disease and resistance development. Study of viral pathogenesis - AIDS, flu and hepatitis, Biology and technology of interferon and antibodies development and their applications. Biology and life cycle of fungi, strain improvement. Role of microorganisms in solid state fermentation - composting of agricultural residues, sewage, waste water and industrial effluents. Integrated pest management and biotechnology. Genetic engineering for crop improvement. Archaebacteria of commercial importance. Current status and potential uses of immobilized enzymes. Role of cell membrane in plasmid replication and partitioning in bacteria. Current advancements/discussions on library assignments.

Micro. 602 Advances in Microbial Physiology 3+0 Sem. I

Origin, evolution, structure, functions and molecular aspects of various cell components. Differentiation in bacteria, slime molds, yeasts.Kinetics of microbial growth, cell division and its mathematical model, death and growth efficiency, economy of energy. Structure and physiology of thermophilic, halophilic and archaebacteria. Molecular aspects of autotrophy in bacteria, their pigments and light harvesting mechanism. Structure and physiology of dormant structures in bacteria. Biochemistry of bacterial capsules. Molecular basis of microbial pathogenicity. Fluidity of cell membrane and transport mechanism. Molecular biology of bioluminescence, bacterial virulence. Heat shock response. Extracellular protein secretion in bacteria. Topics of current interest in molecular microbiology.

Micro. 603 Regulation of Microbial Biosynthesis 2+0 Sem. II

Biosynthesis of small molecules - amino acids, purines and pyrimidines and macromolecules - proteins and nucleic acids. Regulation of initiation, termination and anti-termination of transcription. Global regulation and differentiation by sigma factor. Regulatory controls in bacteria - inducible and biosynthetic pathways. Ribosomal RNA and ribosomal protein regulation under stress condition. Specific regulatory systems; SOS regulatory control; Antisense RNA regulation of gene expression. Morphogenesis and differentiation in bacteria. Biosynthesis of secondary metabolites in microbes.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 etc.

Micro. 604 Advances in Soil Microbiology 3+0 Sem. I

Survival and dispersal of microorganisms. Microbial successions and transformation of organic matter. Role of microorganisms in soil fertility. Molecular ecology and biodiversity of soil microorganisms. Bioremediation: mechanism, application in remediation of polluted soils. Biological control: mechanism, types and applications. Mechanism of nitrogen fixation. N_2 fixation in free living heterotrophs and cyanobacteria.Actinorrhizal symbiosis. Genetics, regulation and molecular biology of N_2 fixation. Molecular basis of legume. Rhizobium specificity N_2 fixation. Extending N- fixation to non-legumes. Mycorrhiza and VAM technology. Biotechnology in agriculture. Interaction between agricultural chemicals, pollutants and soil microorganism and other related topics of current interest.

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

Organization of genetic material in prokaryotic and eukaryotic cell. Gene expression - DNA - protein interactions. Genetic recombination- General and specific recombination following gene transfer - transformation, transduction and conjugation. Bacterial plasmids - replication, maintenance and functions. Bacteriophages-structure, lytic and lysogenic cycle, molecular mechanism of adsorption and infection. Insertion sequences and transposons-structure, replication and application in improvement of microbial expression with respect to industry and agriculture. Molecular mechanism of site specific mutagenesis. Protein Engineering. Recombinant DNA technology- DNA isolation, vector designing, cloning, PCR amplification, expression of genes and its application in industry/agriculture. Concepts of proteomics and genomics.

Micro. 606 Advances in Fermentation **3+0** **Sem. I**

An overview of fermentation - current status of fermentation industry. Fermentor design, high performance bioreactors, mass and energy transfer in bioreactors. Instrumentation and control in fermentors - on line measurements systems, computer application. Substrates for industrial fermentation. Energy and liquid fuels from renewable sources. Process development and fermentation kinetics. Biofertilizers. Isolation, recovery and purification of fermented products. Genetic engineering and it's industrial application. Industry and environment. Fermentation economics. Industrial accidents, prevention and preparedness. Microbial production of health care products. Antibiotic fermentation, steroid fermentation. Production of secondary metabolites. Yeast technology- classification, genetics, improvements for brewing, baking and distilleries. Topics of current interest in fermentations.

Micro. 591 Seminar

Micro. 600 Master's Research

Micro. 700 Ph.D. Research

ZOOLOGY

PROGRAMMES
M.Sc.
Ph.D.
Five Year Integrated M.Sc. (Hons)
COURSE REQUIREMENTS

M.Sc.

Field of Specialization	Animal Physiology, Biosystematics and Biodiversity, Fisheries, Fresh Water Ecology, Parasitology, Vertebrate Pest Management.
Required Courses	Zoo. 501, Zoo. 502, Zoo. 503, Zoo. 504, Zoo. 505.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than the Minor) relating to area of special interest and research problem.
Minor Fields	Biochemistry, Biotechnology, Botany, Entomology, Nematology, Food Science and Technology or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the Student's Advisory Committee and approved by the Dean, Postgraduate Studies.

Ph.D.

Field of Specialization	Animal Physiology, Biosystematics and Biodiversity, Fisheries, Fresh Water Ecology, Parasitology, Vertebrate Pest Management
Required Courses	Zoo. 601, Zoo. 602.
Supporting Courses	Courses from subject matter fields (other than the Minor) relating to area of special interest and research problem.
Minor Fields	Biochemistry, Biotechnology, Botany, Entomology, Nematology, Food Science and Technology or any other as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

Five Year Integrated M.Sc. (Hons)

Field of Specialization	Animal Physiology, Biosystematics and Biodiversity, Fisheries, Fresh Water Ecology, Parasitology, Vertebrate Pest Management
Required Courses	All courses listed for Semester I-VI (P-___*) and Zoo. 501, Zoo. 502, Zoo. 503, Zoo. 504, Zoo. 505.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than the Minor) relating to area of special interest and research problem.
Minor Fields	Biochemistry, Biotechnology, Botany, Entomology, Nematology, Food Science and Technology or any other field as approved by the Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

* Page number according to new RBI.

DESCRIPTION OF COURSE CONTENTS

Undergraduate courses/Integrated M.Sc. (Hons)

Zoo. 51 Fish Production 1+1 Sem. II

Importance of fish and fisheries. Types of fisheries: capture and culture fishery. Fishing gears and crafts. Scope of Inland fisheries in the agro-climatic regions of Punjab. Survey of fish fauna: indigenous and exotic/introduced species. Fishes of economic importance. Selection of fish for culture purposes. Management of typical fish farm. Fish nutrition and feeding. Techniques of induced breeding and their importance. Production of fish seed. Fish hatcheries and their importance. Economic importance of fish. Fish diseases. Integrated fish farming. Introduction to fish post-harvest technology.

Practical: Determination of water quality parameters - turbidity, pH, dissolved oxygen etc. Qualitative and quantitative analysis and identification of phyto- and zooplankton. Anatomy of fish, identification of culturable fishes. Fish predators. Fish feeds. Identification of fishing gears/nets. Induced breeding techniques. Production of fish seed. Visit to an operational fish farm.

Bio. 91 Introductory Biology 3+1 Sem. I

Diversity in Living World - What is living, Biodiversity, Need for classification, Three domains of life, Taxonomy & Systematics. Concept of species and taxonomical hierarchy, Binomial nomenclature, Tools for study of Taxonomy, Museums and Zoos. Five Kingdom classification - salient features and classification of Monera, Protista and Fungi into major groups. Lichens, Viruses and Viroids. Salient features and classification of plants into major groups - Algae, Bryophytes, Pteridophytes, Gymnosperm and Angiosperm (three to five salient and distinguishing features and at least two examples of each category). Angiosperms-classification up to class, characteristics features and examples. Structural organization in animals and salient features and classification of Animals - non chordate up to phyla level and chordate up to class level (three to five salient features and at least two examples). Structural organization in plants - morphology and modifications, functions of different parts of flowering plants - root, stem, leaf, flower, fruit and seed. Inflorescence - cymose and racemose. Morphology, anatomy and functions of different systems (digestive, circulatory, respiratory, nervous and reproductive) of an insect (cockroach) (Brief account only).

Practical: Study of parts of a compound microscope. Study of the specimens and identification with reasons - Bacteria, Oscillatoria, Spirogura, Rhizopus, mushroom, yeast. Study of the specimens and identification with reasons - liverwort, moss, fern, pine, one monocotyledonous plant, one dicotyledonous plant and one lichen. Study and describe three locally available common flowering plants from each of the following families (Solanaceae, Fabaceae and Liliaceae) including dissection and display of floral whorls, anther and ovary to show number of chambers. Types of root (tap and adventitious), stem (herbaceous and woody) and leaf (arrangement, shape, venation, simple and compound). Study of different modifications in root, stem and leaves. Study and identification of different types of inflorescence. Study of specimens and identification with reasons - Amoeba, Hydra, liverfluke, Ascaris, leech, earthworm, prawn, silkworm, honeybee, snail and starfish. Study of specimens and identification with reasons - shark, rohu, frog, lizard, pigeon and rabbit.

Bio. 92 Cell Structure and Function 3+1 Sem. I

Cell structure and function (Introduction). Cell theory and cell as the basic unit of life. Structure of prokaryotic and eukaryotic cell. Plant cell and animal cell - cell membrane and cell wall. Cell organelles structure and function - endomembrane system, endoplasmic reticulum, golgi bodies, lysosomes, vacuoles, mitochondria, ribosomes, plastids and microbodies. Cytoskeleton - cilia, flagella and centrioles (Ultrastructure and function). Chemical constituents of living cells:

biomolecules - structure and function of proteins, carbohydrates, lipid and nucleic acids. Enzymes - types, properties and enzyme action. Cell division - cell cycle, meiosis, mitosis and their significance. Plant tissues - anatomy of root, stem and leaf. Animal tissues.
Practical: Study of tissues and diversity in shapes and sizes of plant (e.g. palisade cells, guard cells, parenchyma, collenchyma, sclerenchyma, xylem and phloem) through temporary/permanent slides. Study of diversity in shapes of animal cells through temporary/permanent slides. Study of tissue - squamous epithelium, muscle fibers and mammalian blood smear through temporary/permanent slides. Study of mitosis in onion root tip cells from permanent slides. Study of mitosis in animal cells (grasshopper) from permanent slides. Preparation and study of T.S. of dicot and monocot roots (primary). Preparation and study of T.S. of dicot and monocot stems (primary).

Bio. 93 Genetics and Evolution/Biology III 3+1 Sem. I
Heredity and variation: Mendelian Inheritance, deviations from Mendelism - incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups. Pleiotropy. Elementary idea of polygenic inheritance. Chromosome theory of inheritance. Chromosomes and genes. Sex linked inheritance - haemophilia, colour blindness. Sex determination - in humans, birds and honey bee. Linkage and crossing over. Mendelian disorders in humans - Thalassemia. Chromosomal disorders in humans - Down's syndrome, Turner's and Klinefelter's syndromes. Molecular basis of inheritance: search for genetic material and DNA as genetic material. Structure of DNA and RNA, DNA packaging and DNA replication. Central dogma - Transcription, genetic code, translation. Gene expression and regulation - Lac Operon. Genome and human genome project. DNA finger printing. Evolution: origin of life, biological evolution and evidences for biological evolution (Paleontological, comparative anatomy, embryology and molecular evidence). Darwin's contribution, modern synthetic theory of evolution, mechanism of evolution - variation (mutation and recombination) and natural selection with examples, types of natural selection. Gene flow, genetic drift, Hardy-Weinberg's principle. Adaptive Radiation, Human evolution.
Practical: Study of prepared pedigree charts of genetic traits such as rolling of tongue, blood groups, widow's peak, colour blindness. Study of analogous and homologous organs in various animals. Study of Mendelian inheritance using seeds of different size of any plant. Exercise on controlled pollination - Emasculation, tagging and bagging.

Bio. 94 Ecology and Environment 3+1 Sem. I
Ecology and environment. Organisms and environment: habitat and niche. Population and ecological adaptations. Population interactions - mutualism, competition, predation and parasitism. Population attributes - growth, birth rate and death rate, age distribution. Ecosystems: patterns, components, productivity and decompositions. Energy flow, Pyramids of number, biomass, energy. Nutrients cycling (carbon and phosphorous). Ecological succession. Biodiversity and its conservation: concepts of biodiversity, patterns of biodiversity, importance of biodiversity, loss of biodiversity, biosphere reserves, national parks and sanctuaries. Hotspots, endangered organisms, extinction, Red Data Book. Environmental issues: air pollution and its control, water pollution and its control, agrochemicals and their effects, solid waste management, radioactive waste management, greenhouse effect and global warming, ozone depletion, deforestation. Any three case studies as success stories addressing environmental issues.
Practical: Collection of water from different water bodies and study them for pH clarity and presence of any living organisms. Study of animals found in xerophytic conditions and comment upon their adaptation ecosystem. Study of animals found in aquatic conditions and comment upon their adaptation ecosystem. Identification of common disease causing organisms like Ascaris, Entamoeba, Plasmodium, ringworm and to study symptoms of diseases that they cause through permanent slides or specimens. Collect soil from different sites and study them

for texture and moisture content. Study the pH and water holding capacity of soil correlating with the kinds of plants found in them. Study the presence of any suspended particulate matter in air at the two widely different sites. Study of plant population density by quadratic method. Study of plant population frequency by quadrate method. Study of plants found in xerophytic conditions and comment upon their adaptation ecosystem. Study of plants found in aquatic conditions and comment upon their adaptation ecosystem.

Zoo. 91 Basics of Animal Physiology 3+1 Sem. II

Digestion and absorption: alimentary canal and digestive glands, role of digestive enzymes and gastrointestinal hormones, peristalsis, digestion, absorption and assimilation of proteins, carbohydrates and fats, egestion. Nutritional and digestive disorders- PEM, indigestion, constipation, vomiting, jaundice, diarrhoea. Breathing and respiration: respiratory organs in animals, respiratory system in humans, mechanism of breathing and its regulation in humans - exchange of gases, transport of gases, regulation of respiration, respiratory volumes. Disorders related to respiration - asthma, emphysema, occupational respiratory disorders. Body fluids and circulation: composition of blood, blood groups, coagulation of blood, composition of lymph and its function. Human circulatory system - structure of human heart and blood vessels. Cardiac cycle, cardiac output, ECG, double circulation, regulation of cardiac activity. Disorders of circulatory system - hypertension, coronary artery disease, angina pectoris, heart failure. Excretory products and their elimination: modes of excretion- ammonotelism, ureotelism, uricotelism. Human excretory system - structure and function, urine formation, osmoregulation, regulation of kidney function - renin-angiotensin, atrial natriuretic factor, ADH and diabetes insipidus. Role of other organs in excretion. Disorders- uraemia, renal failure, renal calculi, nephritis, dialysis and artificial kidney. Locomotion and movement: types of movement - ciliary, flagellar, muscular. Skeletal muscle - contractile proteins and muscle contraction. Skeletal system and its functions, joints. Disorders of muscular and skeletal system - myasthenia gravis, tetany, muscular dystrophy, arthritis, osteoporosis, gout. Neural control and coordination: neuron and nerves. Nervous system in humans - central nervous system, peripheral nervous system and visceral nervous system. Generation and conduction of nerve impulse, reflex action. Sense organs: sensory perception, elementary structure and function of eye and ear. Chemical coordination and regulation: endocrine glands and hormones. Human endocrine system - hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal, pancreas, gonads. Mechanism of hormone action, role of hormones as messengers and regulators, hypo- and hyperactivity and related disorders (common disorders e.g. dwarfism, acromegaly, cretinism, goiter, exopthalmic goiter, diabetes, Addison's disease). Diseases related to all the human physiology systems in brief.

Practical: Test the presence of urea in urine. Detect the presence of sugar in urine/ blood sample. Detect the presence of albumin in urine. Detect the presence of bile salts in urine. General study of human skeleton. Study of skull and jaw bones (upper and lower). Study of ribs. Study of vertebrae. Study of forelimb. Study of hind limb.

Zoo. 92 Animal Reproduction and Human Welfare 3+1 Sem. II

Reproduction: Human reproduction - male and female reproductive systems, microscopic anatomy of testis and ovary. Gametogenesis - spermatogenesis and oogenesis. Menstrual cycle. Fertilization, embryo development upto blastocyst formation, implantation. Elementary idea of pregnancy and placenta formation, parturition, lactation. Reproductive health: need for reproductive health and prevention of Sexually Transmitted Diseases (STD). Birth control - need and methods, contraception and Medical Termination of Pregnancy (MTP). Amniocentesis. Infertility and Assisted Reproductive Technologies - IVF, ZIFT, GIFT. Biotechnology and its applications: principles and processes of biotechnology, genetic engineering (recombinant DNA technology). Application of biotechnology in health, human insulin production, gene therapy. Genetically modified organisms - transgenic animals. Biology and human welfare. Health and

diseases: pathogens, parasites causing human diseases (malaria, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring Worm). Basic concepts of immunology. Vaccines, Cancer, HIV and AIDS. Adolescence, drug and alcohol abuse. Apiculture and animal husbandry. Microbes in human welfare: in household food processing, industrial production, sewage treatment, energy generation and as biocontrol agents and biofertilizers.
Practical: Study and identify stages of gamete development i.e. T.S. of Testis and T.S. of Ovary through permanent slides. Study of meiosis in grasshopper testis through permanent slides. Study of T.S. of Blastula through permanent slides. Identify Ascaris, Entamoeba, Plasmodium and Ringworm - comment on symptoms of diseases that they cause through permanent slides or specimens.

Bio. 101 Introduction to Biology 3+0 Sem. I
Plant kingdom, features of each group, parts of angiospermic plants, morphology of plant parts, pollination and fertilization, fruit and seed. Introduction to photosynthesis and respiration. Process of growth and development. Cell structure, differences between plant and animal cell, cell division and biomolecules. Simple and compound tissues. Functional organization of a mammal. Development of frog upto three germinal layers. Classification and general survey of animal kingdom.

Bio. 102 Introductory Biology 1+1 Sem. I
Introduction to the living world, diversity and characteristics of life, origin of life, evolution and eugenics. Binomial nomenclature and classification. Cell and cell division. Morphology of flowing plants. Seed and seed germination. Plant systematic – viz., Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.
Practical: Morphology of flowering plants - root, stem and leaf and their modifications. Inflorescence, flower and fruits. Cell, tissues and cell division. Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants - Brassicaceae, Fabaceae and Poaceae.

Bio. 103 Biodiversity and its Conservation 2+0 Sem. II
Concept of biodiversity, bioresource and wildlife management. Conservation strategies - in situ and ex situ conservation - wild life conservation projects in India, protection of biodiversity for its suitable utilization, threats to biodiversity. WCU Red Data book. Biodiversity hotspots in India. National bureaus of genetic resources. Sustainable development. Diversification of crops and cropping system vis a vis maintenance of on farm biodiversity. Centres of origin of crops, diversity of indigenous livestock and crops. Vulnerability and extinction of flora and fauna. Endangered species in various ecosystems, germplasm banks. Environmental impact assessment, bioremediation and biosafety. Introduction to national and international regulatory agencies, legislation and International treaties.

Zoo. 101 Basic Zoology 2+1 Sem. II
Introduction to Zoology. Structure and functions of cell and cell organelles. Difference between prokaryotic and eukaryotic cell. Cell division - mitosis and meiosis. Structure and function of biomolecules. Types of simple and compound tissues. Binomial nomenclature. Classification and general survey of animal kingdom. Functional organization of various systems of a mammal - digestive, circulatory, respiratory, excretory, nervous and reproductive. Laws of inheritance. Multiple allelism (blood groups). Genetic disorders in human and their inheritance.
Practical: Study of animal cell structure and cell division. Histological preparation of simple and compound tissues. General survey of animal kingdom up to phyla in invertebrates and up to classes in vertebrates. Demonstration of mammalian anatomy. Blood grouping.

Zoo. 103 Elementary Human Physiology 2+1 Sem. I

Introduction to anatomy and physiology and structural organization of body. The cell -structure, its organelles, functions and multiplication, different types of cells and their functions. Movement of particles across cell membrane - Active transport and passive transport. Body fluids and its compartments and functions. Water output and input into the body and maintenance of water balance in human body. The tissues - types, structure and their functions. The skeletal system - anatomy and functions, structure, formation and development of bones, different types of bones and types of joints and their movements. Circulatory system: the blood - composition and function, blood clotting and blood grouping, Heart - structure, functions, types of circulatory systems, blood pressure and heart rate and factors affecting it, electrocardiogram. The respiratory system: anatomy, functions, mechanism of breathing and respiratory volumes, gas transport and respiratory adaptation. The digestive system: anatomy and functions of alimentary tract and accessory organs, process of digestion of food, absorption and assimilation of digested food, enzymes involved in digestion of food, liver - structure and functions, pancreas - structure and functions. The urinary system: anatomy and functions, formation and composition of urine. The endocrine system: important ductless glands of the body and their functions. The reproductive system: male reproductive system – anatomy and functions, female reproductive system - anatomy and functions, menstrual cycle. The nervous system: elementary study of anatomy and functions. Sensory organs: anatomy and functions. Glossary of terms used in physiology

Practical: Demonstration of animal viscera, identification of systems and organs, identification of cells - epithelial, muscle, nerve etc. Transverse section of stomach, intestine - small and large. Demonstration of specimens of spleen, kidney and brain. Models of excretory and reproductive organs and their histology. Colorimeter. Estimation of RBC count by hemocytometer. Estimation of WBC count by hemocytometer. Differential counting of WBC using peripheral smear. Estimation of PCV, ESR, micro and macro heamatocrit. Estimation of bleeding and clotting time and blood groups. Measurement of pulse rate and blood pressure, its variation with exercise. Testing for sensation, special sensors, measurement of body temperature, diurnal variations.

Zoo. 201 Introduction to Animal Biodiversity 3+0 Sem. I

Description of biodiversity. General characteristics and outline of classification of different animal groups. Locomotion and reproduction in Protista. Skeletal and canal system in Porifera. Metagenesis, polymorphism, corals and coral reefs in Coelenterata. Parasitic adaptations and evolution of parasitism in Helminthes. Coelom, metamerism, excretion and polymorphism in Annelida. Vision, respiration and larval forms in Arthropods. Torsion and de-torsion, shell and respiration in Mollusca. Water vascular system and larval forms in Echinodermata. Salient features of protochordates. Respiration, osmoregulation and migration in fish. Respiration and parental care in Amphibia. Terrestrial adaptations and parental care in Reptiles. Respiration, flight and endothermy in birds. Integument, dentition in mammals and evolution of man.

Zoo. 203 Introduction to Cell Biology and Immunology 3+0 Sem. II

Cell structure, cell theories and cell division. Cell membrane and its models. Transport mechanisms and junctions. Cell organelles - mitochondria - structure and function. Racker's experiment. Nucleus - structure and functions, nuclear pore complex, nucleolus and its functions. Ribosomes, ER, Golgi apparatus, microbodies, lysosomes and peroxisomes. Structure of cilia and flagella. Cell coat, cell-recognition and cell-cell interactions. Overview of immune system - innate and acquired immunity, generation of immunogenicity, recognition of antigens, properties of B-cell and T-cell epitopes, antigen-antibody interactions, immune effect or mechanisms, cytokines, complement system and hypersensitive reactions. Immune system in health and disease, vaccines, autoimmunity, AIDS and diagnostic tools.

Zoo. 204 Introduction to Developmental Biology 2+0 Sem. I

Introduction and scope of embryology. Gametogenesis, types of eggs, fertilization,

parthenogenesis, cleavage, blastulation, gastrulation in frog, chick and mammals, fate of germ layers and formation of extra-embryonic membranes in chick. Human placenta (physiology and types). Embryonic induction - nature and action of organizer, tissue interactions and basis of induction. Differentiation. Post-embryonic morphogenesis. Larvae and their significance. Metamorphosis. Regeneration. Amniocentesis. Stem cell culture and cloning. Gene transfer into animal oocytes, embryos and tissues, biosafety and ethical issues of cloning. Growth. Ageing. Teratology - causes and examples.

Zoo. 304 Fundamentals of Animal Physiology 3+0 Sem. I

Compound tissues and types of glands. Heterotrophic forms of nutrition, transport and mixing of food in the alimentary canal, secretory functions of digestive tract, digestion, absorption and malfunctions of GIT. Pulmonary ventilation, physiological principle of gaseous exchange, transport of oxygen and CO_2 in the blood and regulation of respiration. Circulating body fluids and blood haemostasis. Heart as a pump, origin and propagation of heart beat, pulse, blood pressure, cardiac cycle and ECG. Functional anatomy of kidney, formation of urine, control of extracellular fluid, osmolality and counter-current mechanism, role of ADH and aldosterone. Physiology of human male and female reproduction. An over-view of other endocrine organs, their hormones and disorders. Functioning of excitable tissues, membrane potential, action potential and its propagation, synaptic and junctional transmission, ultra structure of the skeletal muscle fibre and molecular mechanism of muscle contraction. Physiology of sense organs and receptors.

Zoo. 305 Fundamentals of Animal Ecology 2+0 Sem. II

Scope and relevance of ecology. Factors of environment - atmosphere, soil, water, light and temperature. Liebig law of the minimum. Shelford law of tolerance. Ecotypes, isolation, evolution, speciation and indicator species. Interaction among organisms - competition, exploitation, predation, herbivory, parasitism and mutualism. Population regulation - abiotic factors, resource and interference competition, niche concept, community structure and dynamics, ecological succession, ecotones, structure and organization of ecosystems and flow of energy and nutrients. Nutrient replenishment. Biogeochemical cycles. Major ecosystems of the world - terrestrial, aquatic and agroecosystems. Zoogeography - barriers and means of dispersal. Bathymetric and geologic distribution. Endemism.

Zoo. 306 Basic Experiments in Zoology 0+3 Sem. I

General survey of Animal Kingdom - characteristics, classification, habits, habitat of important animal representatives of each phyla and classes and visit to Zoological Museum. Study of slides of cell and cell division. Demonstration of antigen-antibody reaction. Demonstration of viscera in earthworm, cockroach and model of frog. Demonstration of activity of salivary amylase, respiratory gill movements in fish, Bleeding and clotting time of blood, and sperm parameters in rat. Slides of gametogenesis and embryonic development in frog and chick. Study of aquatic, terrestrial and agroecosystems.

Zoo. 307 Systematics and Evolution of Animals 2+1 Sem. I

Introduction to systematic zoology and its importance. Systematics and phylogeny. Zoological nomenclature, classification and concept of modern trends in systematics. Origin of life, concept of evolution, different theories of evolution, evolution of land vertebrates and man. Adaptations.
Practical: Identification of animals using modern and conventional methods.

Zoo. 308 Applied Zoology 3+1 Sem. II

Useful animals and their products. Outlines of apiculture, sericulture, lac culture, edible and pearl oyster culture, pisciculture/aquaculture, poultry farming, dairy farming etc. Important human and veterinary parasites - protozoan and helminths. Life cycle and biology of

Plasmodium, Trypanosoma, Leishmania, Ascaris, Wuchereria, Fasciola, Schistosoma and Taenia. Molecular, cellular and physiological basis of host parasite interactions. Arthropods and vectors of human diseases (mosquitoes, lice, flies and ticks). Mode of transmission of pathogens by vectors. Chemical, biological and environmental control of arthropod vectors. Biology and control of chief insect pests of agricultural importance. Bird pests and their control. Life cycle, damage and control of rodent pests of agriculture.
Practical: Study/survey of economically important animals. Study of protozoan, helminth parasites and arthropod vectors associated with human diseases. Study of vertebrate pests of agricultural crops and their control.

Zoo. 309 Zootechniques 1+1 Sem. II
Collection, maintenance, rearing, upkeep of animals in captivity, preservation (dry and wet techniques), classification, labelling etc. Ethical issues related to animal health and their use for zoological studies. Collection of tissues and fluids from animals. Routes of administration of test chemicals to animals. Preparation of reagents, fixatives, stains and tissue processing for histological preparations. Details of microtomy. Basic and selective staining methods. Frozen cryo cut sections and principles of histo-chemistry. Principles of microscopy and its upkeep. Tissue processing for biochemical estimations.
Practical: Collection of small and large animals. Preservation of specimens for museum. Demonstration of injection routes and collection of fluids in albino rat. Sacrificing the animal and fixation of material and its processing for histological studies of selected organs of rat. Section cutting, stretching, staining and mounting of sections and their microscopic study.

Zoo. 310 Fundamentals of Animal Behaviour 2+1 Sem. I
Definition of behaviour. Psychology versus ethology and contemporary animal behaviour. Basic concepts and models of classical ethology. Types of behaviour. Social behaviour. Migration and dispersal. Coevolution of prey-predator behaviour.
Practical: Study of chemotaxis, feeding preferences and behaviour using animal maze.

Zoo. 311 Fundamentals of Applied Human Physiology 3+0 Sem. I
Introduction to cell physiology and membrane transport mechanisms. Physiology of digestion, absorption and GIT movements. Mechanism of external and internal respiration, hypoxia, apnea, asthma and dyspnea. Composition and functions of blood and lymph. Blood grouping and its transfusion. Anaemia and thalassemia. Circulation - cardiac output, blood pressure, pulse, ECG, hypertension and artheroseclerosis. Mechanism of urine formation and haemostasis, micturition, kidney failure and dialysis. Mechanism of muscle contraction and physiology of exercise and fatigue. Functional neuroanatomy - action potential, nerve impulse and reflexes. General sensory receptors and physiology of special senses vision, hearing, equilibrium and their disorders. Hormonal functions of various endocrine glands and their disorders. Physiology of male and female reproduction, puberty, pregnancy, parturition, lactation and menopause.

Zoo. 312 Immunology 2+1 Sem. I
History and scope of immunology. Components of immune system - organs, tissues and cells, Immunoglobulin structure and functions. Molecular organization of immunoglobulins and classes of antibodies. Antibody diversity - antigens, haptens, antigens antibody interactions. Immuno-regulation and tolerance. Allergies and hypersensitive response. Immunodeficiency. Vaccines - live attenuated vaccines, killed vaccines, cell culture based vaccines, recombinant vaccines. Immunological techniques. Immunological application in plant science, monoclonal antibodies and their uses. Molecular diagnostics.
Practical: Preparation of buffers and reagents. Precipitation and agglutination test, HA, HI test. Immunoblotting, immunoelectrophoresis and fluorescent antibody test. Enzyme immunoassays

including ELISA variants, Western blotting. Raising of antisera in laboratory animals. Collection and preservation of antisera - separation, filtration and aliquoting.

Zoo. 313 Animal Biotechnology 3+1 Sem. I

History of animal biotechnology. Basic techniques in animal cell culture. Introduction to embryo biotechnology - oocyte collection and maturation, sperm preparation and in vitro fertilization. Cryopreservation of oocyte, sperm and embryos. Embryo transfer technology. Breeds of livestock and their characteristics. Marker assisted breeding of livestock. Introduction to animal genomics - RFLP, RAPD, SSRs, QTL, SNP, STR, Mitochondrial DNA polymorphism. Rumen and its environment - Rumen microbes and manipulation of rumen microbes for better utilization of feed. Introduction to nutrigenomics- milk biome, manipulation of lactation by biotechnological tools. Application of biotechnology in meat and meat products. Genome and protein based diagnostics of important animal diseases - FMD, brucellosis, PPR, Mastitis, Blue tongue, Newcastle disease.

Practical: Basic cell culture techniques - oocyte aspiration from ovaries, sperm preparation and in vitro fertilization. PCR based detection of animal pathogens, PCR-RFLP. Immunohistochemical localization of protein marker in tissues/cells - meat species identification by PCREDIT.

Zoo. 401 Form, Structure and Function of Invertebrates 3+1 Sem. II

General characteristics and outline of classification of different animal groups upto classes. Interrelationships amongst the major and minor invertebrate phyla. Functional anatomy and physiology of locomotion, digestion, respiration, circulation, excretion, neural and endocrine regulation, reproduction, sense organs and receptors of invertebrates. Larval forms and their evolutionary significance.

Practical: General survey of invertebrate forms. Study of histological preparations of organs representing different systems. Dissection of earthworm, cockroach and pila to demonstrate various systems. Experiments to demonstrate the response of some invertebrates to photic, mechanical, thermal, chemical and electrical stimuli.

Zoo. 402 Form, Structure and Function of Vertebrates 2+1 Sem. II

General characteristics and outline of classification of different animal groups upto orders. Functional anatomy and physiology of muscular, digestive, respiratory, sensory, circulatory, excretory, nervous, endocrine and reproductive systems of vertebrates.

Practical: General survey of vertebrate forms. Demonstration of animal viscera. Study of histological preparations of organs representing different systems. Demonstration of heart beat of frog. Demonstration of neuronal and muscular activity. Study of reproductive cyclicity in female rat.

Zoo. 403 Cell Biology and Development in Animals 2+1 Sem. II

A detailed account of structure and functions of cell and cell organelles. Cell cycle and its regulation. Cell membrane - its chemical structure and models. Membrane differentiation, junctions and transport mechanisms, Cell coat (glycocalyx) and cell recognition, cell-cell interactions, cell signalling and cell migration. Extracellular matrix of animal cell. Cytoskeletal organelles and their functions, cellular nitches, stem cells and properties of excitable cells-neurons and muscles. Cell differentiation. Cell death (apoptosis) and cancer cells. Introduction to developmental biology. Mechanism of sex determination. Gametogenesis and fertilization. Embryonic development, cleavage patterns, blastulation, gastrulation movements in frog, chick and man and fate of germ layers. Extraembryonic membranes and placenta (physiology and types). Cell differentiation and morphogenetic movements. Induction and regeneration. Genes in development. Growth. Gerontology - ageing, concept and model. Teratology and teratogens.

Practical: Study of structure of special cells. Gametogenesis in gonads. Study of cleavage,

blastulation, gastrulation in frog and chick eggs and preparation of slides.

Zoo. 404 Environmental Biology and Management 2+1 Sem. II

Concepts and dynamics of ecosystem, components, food chain and energy flow, productivity and biogeochemical cycles. Types of ecosystems, population ecology and biological control. Community structure and organization. Environmental pollution. Sustainable development. Economic importance of microbes, plants and animals. Bioresource management and regional conservation strategies - examples with reference to India. Wildlife management - sanctuaries, parks and biosphere reserves in India. Endangered and threatened animal species in India, Red data book, germplasm banks. Environmental issues impact of urbanization and industrialization and its assessment, disaster management, bioremediation and biosafety. Policies, regulatory agencies and legislation.

Practical: Study of different climatic factors - temperature, relative humidity, wind velocity and light intensity. Estimation of physico-chemical characteristics of soil and water. Ecological adaptations of animals in different habitats. Population estimates of planktons. Visit to national parks/sanctuaries and waste management parks.

Zoo. 405 Introduction to Fish and Fisheries 2+1 Sem. I

Importance of fishery science. Capture and culture fisheries of India. Classification of fishes. Lacustrine and riverine fisheries of Punjab. Biology of some freshwater, brackish water and marine food fishes. Effects of dams and pollution on fish and fisheries. Inland fishing gears. Management and conservation of Inland fishery resources.

Practical: Collection, identification and classification of fishes of economic importance. Study of different types of nets and demonstration of fishing operation. Visit to field/fish market to analyse species composition, their size and sex ratio in a commercial catch. Assessment of fish stock.

Zoo. 426 Applied Human Physiology 3+0 Sem. I

Introduction to cell and organ physiology. Movement of molecules through cell and other biological membranes. Composition and functions of blood and lymph, blood clotting, blood groups, blood transfusion, anaemia, thalassemia, inflammation, organ transplant, hypersensitivity and immunodeficiency syndromes. Physiology of digestion, absorption, GIT movements and constipation. Respiration - control of ventilation, gaseous exchange and transport, hypoxia, apnea, asthma and dyspnea. Circulation - cardiac output, systemic blood pressure, pulse, ECG, hypertension and artherosclerosis. Excretion - mechanism of muscle contraction and physiology of exercise and fatigue. Functional neuroanatomy - nerve fibre, synapse, action potential, nerve impulse and reflexes. General sensory receptors. Special senses retina photochemistry of vision and its disorders, hearing and its impairment. Functions of hormones of pituitary gland, thyroid, parathyroid, adrenal cortex, pancreas and endocrine disorders. Physiology of male and female reproduction, puberty, pregnancy, lactation and menopause

Postgraduate Courses

Zoo. 501 Functional Anatomy and Physiology of Animals 3+1 Sem. I

Functional anatomy and physiology of digestive, respiratory, circulatory, excretory, muscular, nervous, sensory, endocrine and reproductive systems of animals. Active transport across membrane. Nutrition, digestion and absorption. Respiration - its types, regulation, breathing mechanism, sites of gas exchange, respiratory pigments and their oxygen carrying capacity. Circulation (open and closed), lymphatic systems, blood composition and functions. Muscular contraction and electric organs. Excretion and osmoregulation. Nerve conduction and neurotransmitters. Major sense organs and receptors. Homeostasis (neural and hormonal). Stress physiology. Reproductive patterns in animals. Bioluminescence.

Practical: Study of endo- and exo-skeletal structures. Histology of different organs. Anatomy of rat and invertebrate types. Demonstration of activity of digestive enzymes (Amylase, Protease, Lipase). Haematological tests - PCV, DLC, TLC and RBC count. Haemoglobin estimation. Demonstration of pneumostatic recording of respiratory movements. Experiments on Q_{10} basal metabolic rate and osmosis.

Zoo. 502 Cell and Developmental Biology 2+1 Sem. I

Structure of pro- and eukaryotic cells. Membrane structure and functions. Intracellular compartments, protein sorting, secretory and endocytic pathways. Cytoskeleton. Nucleus. Mitochondria and chloroplast and their genetic organization. Cell cycle. Cell-cell interactions and signal transduction. Structure and organization of chromatin, polytene and lampbrush chromosomes. Dosage compensation and sex determination. Sex-linked inheritance. Gametogenesis. Molecular events during fertilization. Cleavage patterns and fate maps. Concepts of sex determination, competence and induction, totipotency and nuclear transfer experiments. Cell differentiation and differential gene activity. Morphogenetic determinants in egg cytoplasm and morphogenesis. Role of maternal contributions in early embryonic development. Genetic regulations in early embryonic development in Drosophila - Homeotic genes. Teratology. Transgenic mice and their medical implications.

Practical: Isolations, fractionation and study of various cell organelles. Demonstration of membrane permeability and transport properties. Permanent microscopic preparations of cell organelles. Estimation of cell size and number. Chromosomal preparations and banding techniques. Use of spectrophotometry and fluorescent microscopy. Study of gametogenesis, cleavage and gastrulation in mammals.

Zoo. 503 Biosystematics and Biodiversity 1+1 Sem. II

Biological nomenclature and theories of biological classification. Modern trends in systematics - structural, biochemical and molecular aspects. DNA fingerprinting and numerical taxonomy. Biodiversity - characterization, magnitude and distribution emphasizing their role as bioindicators of habitat quality, generation, maintenance and loss. Economic value. Human impact and biodiversity. Diversity and conservation of Punjab fauna. Conservation strategies. Role of NGOs in biodiversity conservation.

Practical: Identification of important animals using conventional taxonomic keys and modern molecular methods. Sampling, extraction methods and identification of soil fauna.

Zoo. 504 Animal Ecology and Bioresource Management 2+1 Sem. I

Interactions between animals and environment. Concept of habitat and niches. Flow of energy, food chain, food web and trophic levels, ecological pyramids and recycling of materials. Biotic community and its dynamics. Nitrogen, Phosphorus, Carbon and Sulfur cycles in nature. Ecosystem dynamics, stability and complexity of ecosystems. Population ecology and biological control. Biological rhythms. Degradation of major terrestrial and aquatic ecosystems of the world. Renewable and non-renewable energy sources and their conservation. Environmental impact assessment. Management of environment and sustainable development.

Practical: Population estimates by capture - marked - recapture, (multiple and single) census. Major abiotic environmental factors. Weather elements and their recording climatographs. Succession in aquatic ecosystem. Food spectrum.

Zoo. 505 Animal Behaviour and Wildlife Management 1+1 Sem. II

Behavioural patterns and their regulation. Feeding, learning, social and sexual behaviours. Parental care. Biological rhythms. Mimicry, dispersal and migration. Background and current status of wildlife management and conservation in India. Biographical notes on important wild animals. Habitat management. Wildlife damage control and mitigating human wildlife conflict. Captive wildlife and wildlife census. Wildlife Protection Act and wildlife projects. Conservation

- principles and strategies. Wildlife in relation to agriculture.
Practical: Demonstrations of fixed action patterns. Maze experiments on animal learning. Food preference. Behaviour of estrous females. Nest building behaviour and mate choice in birds. Identification of wildlife species and preparation of inventory. Economic evaluation of wildlife areas. To study management practices. Visit to Zoo and sanctuaries.

Zoo. 506 Life History and Reproductive Strategies of Invertebrates 2+1 Sem. II
Life histories of major groups of invertebrates and selection mechanism of population regulation. Reproductive patterns in invertebrates - asexual methods and their environmental regulation, sex differentiation and development of reproductive organs. Oogenesis and spermatogenesis and their neuroendocrine regulation. Fertilization and egg production. Alternation of generations, metamorphosis and parthenogenesis.
Practical: Study of asexual reproduction, gametogenesis, gametes and accessory reproductive organs. Demonstration of neurosecretory cells in invertebrates.

Zoo. 507 Comparative Vertebrate Endocrinology and Reproduction 2+1 Sem. II
Neuroendocrine regulation, structure, secretion and functions of endocrine glands. Mechanisms of hormone action. Reproductive patterns and their evolution in vertebrates. Environmental regulation of reproductive cyclicity. Sex determination. Hormonal regulation of gametogenesis and ovulation. Gamete maturation, fertilization, implantation, pregnancy, parturition, lactation, fertility and its regulation.
Practical: Study of different endocrine glands and reproductive organs. Demonstration of methods of hormone assay. Qualitative and quantitative study of steroid biosynthesis (key enzymes, lipids, cholesterol). Determination of sperm concentration and motility. Study of estrous cycle in rat. Induction of sperm capacitation in vitro.

Zoo. 508 Biology and Management of Birds 2+1 Sem. I
Origin and evolution of birds. Adaptations for flight. General survey and zoogeography. Skin, scales, feathers and moulting. Types and aerodynamics of flight. Feeding habits. Birds as biological indicators. Reproduction - courtship and mating habits, nests, eggs, incubation, brood parasitism. Brooding and care of young. Population dynamics. Migration and homing. Reproductive and behavioural manipulations for management of birds. Relationship with man - useful and harmful aspects. Management of birds with particular reference to agriculture.
Practical: Survey of birds of agricultural importance. Types of nests and nesting sites. Bird census. Population estimation parameters. Mapping of nesting/roosting sites. Capturing and marking methods. Nesting and perching provision. Estimation of damages by birds and demonstration of methods for their management.

Zoo. 509 Biology and Management of Mammalian Pests 2+1 Sem. II
Mammalian pests, their classification and status. Biotic and abiotic factors affecting population dynamics, demography patterns and r & k selection strategies. Morphological, physiological and behavioural adaptations. Foraging strategies, habitat selection, social organization and mate selection. Principles of mammalian pest management, risk assessment, impact on environment, pest control legislation and policies. Rodent pests of agricultural crops and stored products, their biology and habitat analysis. Population and damage assessment. Rodent pest management strategies - types of rodenticides and their mode of action, repellents/antifeedants, fertility control using synthetic chemicals and plant products, immunocontraception, mechanical control, environmental control, biological control and use of synthetic pheromones and predatory cues. Integration of different pest management strategies.
Practical: Collection, identification and preservation of rodent pests, estimation of population by different methods, damage assessment methods in different crop fields, burrow structure and methods of control with special reference to agriculture.

Zoo. 510 Parasitology **2+1** **Sem. II**

Introduction to parasitology. Morphology and life cycles of protozoan and helminth parasites of economic importance including Zoo and wild animals. Life cycle and control of arthropod and mollusc vectors. Diagnosis and control of parasitic infections. Immunity to parasites. In vitro culture of parasites. Conventional and novel methods of control of protozoan and helminth parasites and vectors. Effect of climate change on proliferation and transmission of parasites.
Practical: Methods of collection, preservation and identification of protozoan and helminth parasites and arthropod vectors. Diagnosis of parasitic infections - conventional and immunological methods.

Zoo. 511 Animal Biotechnology **2+1** **Sem. I**

History and scope of biotechnology. Brief review of concepts and trends in cell, tissue and organ culture. Somatic cell hybridization, hybridoma technology, monoclonal antibody production and their application. Introduction to immune system, cellular and humoral immune response, vaccines, methods of vaccine production and antigen-antibody based diagnostic assays. Biotechnologies involved in induced breeding of animals including artificial insemination, superovulation, in vitro fertilization and embryo transfer. Gene mapping, gene cloning and gene transfer. Transgenesis and animal cloning. Application of biotechnology in agriculture, veterinary science, pharmaceutical industry, food industry, chemical industry and environment.
Practical: Preparation and sterilization of culture media. In vitro culturing of somatic cells. Basic techniques in hybridoma and monoclonal antibody production. Induction of superovulation and embryo collection in mice. Oocyte maturation and capacitation in vitro. In vitro fertilization.

Zoo. 512 Freshwater Ecology **2+1** **Sem. II**

Introduction to limnology. Kinds of inland aquatic habitats. Physical, chemical and biological limnology of lakes, reservoirs, wetlands, streams and irrigation canals. Major communities of fresh water - plankton, nekton, neuston and benthos. Mineral cycles. Biodegradation in different aquatic ecosystems. Biology of polluted waters. Impact assessment of exotics in inland waters. Lake and reservoir restoration.
Practical: Use of limnological instruments. Study of the animal communities inhabiting inland waters. Estimation of physico-chemical parameters of freshwaters. Estimation of chlorophyll in phytoplanktons.

Zoo. 513 Fish Production Technology **2+1** **Sem. I**

Principle of aquaculture. Fish in ponds, cages, pens, raceways, running waters and recirculatory system. Integrated fish farming and recycling of wastes. Pond productivity. Management strategies for increasing fish production in semi-intensive fish culture system. Nutrient requirements of fish. Fish feed formulation and feeding strategies. Non-food aquaculture.
Practical: Identification of important cultivable freshwater fish and prawn species. Water and soil quality analysis. Impact of manuring on water quality, plankton production and fish growth. Estimation of pond productivity. Formulation and preparation of balanced fish feed. Proximate analysis of fish feed.

Zoo. 514 Fish Breeding, Genetics and Biotechnology **2+1** **Sem. I**

Biology of gametogenesis and fertilization. Breeding behaviour and parental care in fishes. Factors affecting fish reproduction. Brood stock management. Breeding techniques and fish seed production. Principles of fish genetics. Chromosomal manipulation and hybridization in fishes. Cryopreservation of gametes. Sex determination. Applications of gene mapping, gene cloning and genetic engineering. Production of transgenic fish.
Practical: Morphology and histology of fish gonads during different reproductive phases. Induced breeding in fishes using different ovulating agents. Different types of fish hatcheries.

Study of developmental stages of fish. Study of fish chromosomes. Demonstration of chromosomal manipulations. Ploidy evaluation using erythrocyte measurements and chromosome number.

Zoo. 601 Advances in Cell and Developmental Biology 2+0 Sem. II

Determinants of cell shape and motility. Dynamic state of membranes - replacement and turnover. Membrane potential and action potentials. Membrane receptors and their dynamics. Transport through clathrin-coated and uncoated vesicles. Interaction between cells and their environment. Cell signalling. Extracellular matrix. Gene organization and regulation. DNA damage and repair. Retroviruses and cellular oncogenes. Biology of cells in culture and animal cell lines. Biosensors and bioprobes. Stem cell biology. Somatic cell cloning. Recent aspects of parthenogenesis and chimeras. Gamete differentiation and molecular mechanisms of fertilization, cleavage, differentiation, induction and morphogenesis. Discussion on current advancements.

Zoo. 602 Advances in Animal Ecology, Behaviour and Bioresource Management 3+0 Sem. II

Energy flow through ecosystems. Biotic factors governing the population growth. Food web and energy flow in wetlands. Diversity and stability in ecosystems and natural communities. Aquatic, terrestrial and atmospheric pollution. Eutrophication. Genetic basis of behavioural patterns, conditioning and nature v/s nurture hypothesis. Mechanism of biological rhythmicity. Social organization, communication mechanisms and basis of cooperation and conflict in animals. Sexuality and mating, reproductive and maternal behaviour in animals. Foraging and refuging systems. Predatory behaviour. Behavioural regulation of animal populations. Major bioresources of the world. Dwindling energy resources and alternatives. Productivity and conservation of resources. Modern concepts in bioresource management. Climate change and bioresource stability. Terrestrial-aquatic ecosystem equilibrium. Principles and applications of remote sensing, GIS and GPS in bioresource management. Role of biotechnology in management of biological resources.

Zoo. 603 Advances in Animal Biotechnology 2+0 Sem. II

Recent aspects of animal cell culturing techniques. Somatic cell hybridization. Cell lines. Commercial scale production of animal cells and their application for in vitro testing. Conventional and recombinant approaches to vaccine production, hybridoma technology. Immunodiagnostics. Biotechnological approaches to reproduction, superovulation, IVF, embryo culture and embryo transfer. In situ and ex situ preservation of germplasm. Cryopreservation of gametes and embryos, embryo sexing and micromanipulation. In vitro testing of germplasm of foetus for genetic defects. Pregnancy diagnosis kits, antifertility vaccines, gene knock out technology and animal models for human genetic disorders. Transgenic animals and applications. Animal cloning. Conservation of endangered species. Stem cells and their applications, ethical and regulatory issues of stem cells.

Zoo. 604 Advances in Biosystematics and Biodiversity 2+0 Sem. II

Evolutionary trends in taxonomy. Recent trends in biosystematics. Molecular basis of hereditary mutation. Mechanism of speciation. Application of biotechnological techniques. Macro evolutionary trends- role of adaptations and incidental effect. Emerging views from comparative biology and geology. Biodiversity at genetic, species, ecosystem and landscape levels. Remote sensing in conservation biology. Biotic response to climate change. Phenological changes in animals. Biodiversity depletion and biological invasion. Factors influencing biodiversity. Biodiversity protection laws, treaties and organization. Management of protected areas.

Zoo. 605 Animal Genomics 2+0 Sem. I

Constituents of the genome, organelle genomes, genes, multigene families and conserved sequences. Coding and non-coding fractions of the genome. Genome sequencing strategies and technologies, conventional approaches, software and informatics for sequencing. STS, EST, SNPs and sequencing length polymorphism. Genetic mapping and technologies - FISH. Outlook of genome sequencing, cDNA projects and cDNA libraries. Expressed sequence tag (EST) - projects for gene identification. Image consortium. Unigene. Functional genomics-positional cloning, microarrays and GFP techniques. Functional analysis of entire genomes. Serial analysis of gene expression (SAGE). Genotypic and phenotypic sequencing in mouse. Genetic diseases and gene therapies.

Zoo. 606 Advances in Reproductive Biology of Invertebrates 2+0 Sem. I
Evolutionary relationships in reproductive patterns in invertebrates. Asexual reproduction - budding, gemmulation, regeneration, autotomy, grafting, fragmentation and their molecular mechanisms. Sexual dimorphism. Sexual reproduction - patterns of sexuality, gametogenesis and mechanism for the release of gametes. Hermaphroditism. Epitoky. Neuroendocrine control of reproduction. Gamete diversity. Variations in mating. Patterns and molecular mechanisms of fertilization. Larval forms, their dispersal and significance in life-history of animals. Environmental cues and invertebrate reproduction. Effect of UV radiations, xenobiotics and environmental pollutants on reproduction of invertebrates.

Zoo. 607 Advances in Reproductive Biology of Vertebrates 2+0 Sem. I
Sex determination and differentiation. Origin of germ cells. Neuroendocrine regulation of reproduction. Role of hypothalamic and extra-hypothalamic areas in fertility regulation. Hormonal and cellular regulation of spermatogenesis and oogenesis in amphibians, reptiles, birds and mammals. Differentiation of the spermatozoan. Cellular and molecular aspects of follicular development and its auto-, para- and endocrine regulation. Mechanism of follicular rupture and release of ovum during ovulation. Post-ovulatory ovarian changes and luteal functions. Structural and functional aspects of male and female reproductive tracts. Sperm and oocyte maturation. Male accessory sex glands, their secretions and composition of the semen. Molecular aspects of fertilization and implantation in various vertebrates. Assisted reproductive techniques. Reproductive cloning, its ethics and application. Discussion on current advancements.

Zoo. 608 Molecular Endocrinology 2+0 Sem. I
Chemical nature, biosynthesis and mechanism of action of hormones. Hormone receptors. Extrahypothalamic areas. Hypothalamo-hypophyseal axis and its control over various endocrine glands, structural and functional aspects of gonads, thyroid, parathyroid, adrenal and other endocrine tissues and mechanisms of their aberrant growth. Endocrine disorders related with fertility, basal metabolism, hypertension, gastrointestinal tract and renal functions. Role of hormones in homeostasis. Functions of prostaglandins, thromboxines and leukotrines. Multiple endocrine neoplasia and humoral manifestations of cancer. Biotechnological advances in endocrinology. Discussion on current advancements.

Zoo. 609 Advances in Biology and Management of Birds 2+0 Sem. I
Anatomical, physiological and behavioural adaptations in birds. Different feeding systems of birds, energy balance and thermoregulation. Avian reproduction, nesting, egg laying and parental care. Social behaviour and territoriality. Principles underlying bird migration. Bird conservation - local, regional and global issues. Regulation of population of birds, their community structure in different agro-ecosystems and functional role. Demography and energy/resource flow interactions with economic analysis of crop. Pest and pest predator interactions. Problems and economic losses due to birds. Management strategies of avian populations. Biological, cultural, mechanical and chemical methods for the control of bird pests

of agriculture. Significance and management of bird predators. Beneficial role of birds in agriculture and their manipulation in biocontrol of insect pests.

Zoo. 610 Advances in Mammalian Pest Management 2+0 Sem. I
Principles of mammalian pest management, mammalian pests, classification of pests and their status, damages caused, risk assessment and impact on environment. Pest control orders, legislation and policy. Pest population monitoring and estimation, radiotelemetry and global positioning. Rodent pests of agricultural crops and stored products. Mammalian pest management strategies. Chemical control - pesticide laws and regulations, pesticide application and safety, toxicants, repellents, antifeedants and attractants. Types of rodenticides and their mode of action. Fertility control using steroids, chemicals and plant products and immunocontraception. Use of semiochemicals for population regulation. Mechanical control - physical killing and trapping. Environmental control - cultural control and habitat manipulation. Biological control - parasites, pathogens, predators and genetically modified agents. Integrated pest management and transfer of mammalian control technology.

Zoo. 611 Advances in Parasitology 2+0 Sem. I
Advances in culture of protozoan and helminth parasites. Physiology and molecular biology of protozoan and helminth parasites. Genetic control of parasites. Strategies for the control of parasitic infections - biological, chemical and immunological. Role of arthropod/molluscan vectors in the transmission of diseases. Strategies for the control of vectors and vector-borne diseases. Chemotherapy and mechanism of anthelminthic resistance. Immune evasion strategies of parasites. Molecular basis of host-parasite interactions. Molecular techniques in diagnosis of parasite diseases. New generation vaccines of protozoa. Problem and prospects of helminth vaccines.

Zoo. 612 Applied Freshwater Ecology 2+0 Sem. I
Community structure and dynamics in lentic and lotic water bodies. Factors influencing community dynamics. Concept of community dynamics indices. Application of basic chemistry principles. Physical, chemical and biological complexes in freshwater ecosystems. Processes controlling elemental cycling in freshwater ecosystems. Soil-water interactions. Availability of nutrients and productivity of aquatic ecosystems. Trophic dynamics in lakes, reservoirs and wetland ecosystems. Horizontal and vertical migrations of plankton. Aquatic pollution. Common transport process of aquatic pollutants like sewage, pesticides, oils, metals, radioactive and biochemical and biomedical wastes etc., in the aquatic environment. Algal blooms and their management. Biodegradation of inland aquatic ecosystems. Current methods of lake and reservoir restoration. Concept and scope of microbial consortia in protection of aquatic environment.

Zoo. 613 Advances in Fish Production Technology 2+0 Sem. I
Advances in aquaculture technologies. Intensive farming systems. Aquaculture engineering. Aquatic microbiology and its significance in fish production. Water-quality criteria for fish production. Advances in fish nutrition and feed technology. Formulation and preparation of nutrient-dense micro encapsulated high-efficiency aqua feeds. Fish feed additives and anti-nutritional factors. Nutritional fish diseases and their management. Applied aquaculture biotechnology. Computer applications in aquaculture. Bioeconomics of fish production. Safety of aquaculture products. Environmental impact assessment.

Zoo. 614 Advances in Fish Breeding, Genetics and Biotechnology 2+0 Sem. I
Advances in fish breeding. Selection index methodologies. Transgenics production and GMOs. Applications of genetics in commercial aquaculture. Research methodologies in fish genetics. Advances in cytogenetics. Molecular breeding. Linear models in fish genetics. Genetic

engineering of eukaryotes. Genetic engineering of bacteria and viruses. Biosafety and patent laws. Functional genomics and proteomics. Protein chemistry and engineering. RNAi technology, regulation of gene expression in prokaryotes and eukaryotes. Types of RNA - rRNA, mRNA, tRNA, miRNA, siRNA, shRNA, tncRNA. Gene knock down. Gene knock out. Co-suppression post-transcriptional gene silencing. RNAi in C. elegans. RNAi and origin of heterochromatin. Applications of genetic engineering to aquaculture. Bioprocess technology.

Zoo. 591 Seminar

Zoo. 600 Master's Research

Zoo. 700 Ph.D. Research

COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUT OF 5-YEAR INTEGRATED M.Sc. (Hons) PROGRAMME IN BIOCHEMISTRY (CORE COURSES)

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES		**Cr. Hrs.** Th+Pr
For PCM base:		
Bio. 101	Introduction to Biology	3+0
For PCB base:		
Math. 107	Fundamental Mathematics	2+1

Regional Language

For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level

Pbi. 101	Basic Punjabi	0+2 (NC)

REQUIRED COURSES

BASIC SCIENCES AND HUMANITIES

Math. 107/ Bio. 101	Fundamental Mathematics/ Introduction to Biology	2+1/3+0
Zoo. 201	Introduction to Animal Biodiversity	3+0
Bot. 202	Plant Morphology	3+0
Econ. 203	Introduction to Economics and Project Evaluation	2+0
Chem. 203	Physical and Inorganic Chemistry	2+1
Eng. 301	Communication Skills and Technical Writing	1+2
Pbi. 101	Basic Punjabi	0+2 (NC)
Stat. 201	Elementary Statistics	2+0
Micro. 202	Introduction to Microbiology	3+0
Phys. 202	Fundamentals of Biophysics	2+1
Biochem. 203	Structure and Function of Biomolecules	3+0
Bot. 203	Systematic Botany	3+0
Zoo. 203	Introduction to Cell Biology and Immunology	3+0
Chem. 204	Mechanism of organic reactions	2+1
Micro. 203	Basic Bacteriology	2+0
Biochem. 204	Metabolism-I	2+0
Bot. 204	Plant Histology	2+0
Micro. 204	Basic Mycology and Phycology	3+0
Zoo. 204	Introduction to Developmental Biology	2+0
Biochem. 205	Metabolism-II	3+0
Bot. 205	Botany of Economic Plants	2+0
Zoo. 304	Fundamentals of Animal Physiology	3+0
Chem. 301/	Fundamental Organic Chemistry/	3+0
Biochem. 303/	Introduction to Membrane Biochemistry	3+0
Bot. 307/	Plant Biodiversity and Environment/	2+1
Micro. 307/	BacterialGenetics	3+0
Zoo. 310/	Fundamentals of Animal Behaviour	2+1
Zoo. 405/	Introduction to Fish and Fisheries	2+1
Agron. 101/	Elements of Agronomy	2+1
PBG 102/	Introductory Genetics	2+0
Ent. 201/	Introductory Entomology	2+1
Pl. Path. 201 (Optional)	Diseases of Field Crops and their Management	2+1

Micro. 205	Basic Virology	2+0
Biochem. 206	General Enzymology	2+0
Bot. 301	Fundamentals of Plant Physiology	3+0
Biochem. 302	Basic Experiments in Biochemistry	0+3
Micro. 305	Basic Experiments in Microbiology	0+3
Zoo. 305	Fundamentals of Animal Ecology	2+0
Mgt. 421	Introduction to Management and Marketing	2+0
Eng. 201	Interactive Languages Proficiency	0+1
Env. 101	Environmental Studies and Disaster Management	2+0
Biochem. 301	Introduction to Molecular Biochemistry	3+0
Bot. 302	Basic Experiments in Botany	0+3
Micro. 304	Introduction to Applied Microbiology	3+0
Zoo. 306	Basic Experiments in Zoology	0+3
Edu. Tour	Educational Tour	0+2 (NC)
Biochem. 423	Fundamentals of Molecular Biochemistry	2+0
Biochem. 425	Fundamentals of Plant Biochemistry	2+0
Biochem. 421	Fundamentals of Biochemistry	3+0
Biochem. 424	Experiments in Biochemistry	0+3
Biochem. 426	Fundamentals of Animal Biochemistry	3+0
Biochem. 429	Biochemical and Biophysical Techniques	3+0
Biochem. 430	Fundamentals of Enzymology	3+0
Biochem. 431	Fundamentals of Membrane Biochemistry	2+0
		109+3/2 (optional)+ 4(NC)=116/115

AGRICULTURE

1	Agron. 101/	Elements of Agronomy/	2+1*
	Ent. 201	Introductory Entomology	2+1*
	PBG 102	Introductory Genetics	2+0*
	Pl. Path. 201	Diseases of Field Crops and their Management	2+1*
2	Biotech. 307	Introduction to Bioinformatics	2+1
3	Biotech. 303	Introduction to Nanobiotechnology	2+0
4	Biotech. 401	Introduction to Genomics and Proteomics	3+0
	(*Credit hours already counted)		8

AGRICULTURAL ENGINEERING AND TECHNOLOGY

1	CSE 101	Information and Communication Technology in Agriculture	1+2

HOME SCIENCE

1	HD 106	Human Values in Education	1+1

NSS/NSO/NCC

1	NSS/NSO/NCC	(SEM-I)	0+1 (NC)
2	NSS/NSO/NCC	(SEM-II)	0+1 (NC)
3	NSS/NSO/NCC	(SEM-III)	0+1 (NC)
4	NSS/NSO/NCC	(SEM-IV)	0+1 (NC)
			4 (NC)
		Total	129/128+4 (NC) =133/132

SEMESTER-WISE PROGRAMME FOR
5-YEAR INTEGRATED M.Sc. (Hons) IN BIOCHEMISTRY

FIRST YEAR			
SEM I		**SEM II**	
Math. 107/Bio. 101	2+1/3+0	CSE 101	1+2
Zoo. 201	3+0	Stat. 201	2+0
Bot. 202	3+0	Micro. 202	3+0
Econ. 203	2+0	Phys. 202	2+1
Chem. 203	2+1	Biochem. 203	3+0
Eng. 301	1+2	Bot. 203	3+0
Pbi. 101	0+2 (NC)	Zoo. 203	3+0
HD 106	1+1	Chem. 204	2+1
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3 (NC)=22	Total	23+1(NC)=24

SECOND YEAR			
SEM III		**SEM IV**	
Micro. 203	2+0	Micro. 205	2+0
Biochem. 204	2+0	Biochem. 206	2+0
Bot. 204	2+0	Bot. 301	3+0
Micro. 204	3+0	Biochem. 302	0+3
Zoo. 204	2+0	Micro. 305	0+3
Biochem. 205	3+0	Zoo. 305	2+0
Bot. 205	2+0	Biotech. 307	2+1
Zoo. 304	3+0	Mgt. 421	2+0
Chem. 301/Biochem. 303/	3+0/3+0/	Eng. 201	0+1
Bot. 307/Micro. 307/Zoo. 310/	2+1/3+0/2+1/	Env. 101	2+0
Zoo. 405/Agron. 101/PBG 102/	2+1/2+1/2+0/		
Ent. 201/Pl. Path. 201 (Optional)	2+1/2+1		
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3/2(optional) +1(NC)= 23/22	Total	23+1 (NC) = 24

THIRD YEAR			
SEM V		**SEM VI**	
Biochem. 301	3+0	Biochem. 421	3+0
Bot. 302	0+3	Biochem. 424	0+3
Biotech. 303	2+0	Biochem. 426	3+0
Micro. 304	3+0	Biochem. 429	3+0
Zoo. 306	0+3	Biochem. 430	3+0
Biotech. 401	3+0	Biochem. 431	2+0
Biochem. 423	2+0		
Biochem. 425	2+0		
Edu. Tour	0+2		
Total	21+2 (NC) = 23	Total	17

COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUT OF 5-YEAR INTEGRATED M.Sc. (Hons) PROGRAMME IN BOTANY (CORE COURSES)

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES		**Cr. Hrs.** Th+Pr
For PCM base:		
Bio. 101	Introduction to Biology	3+0
For PCB base:		
Math. 107	Fundamental Mathematics	2+1

Regional Language

For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level

Pbi. 101	Basic Punjabi	0+2 (NC)

REQUIRED COURSES

BASIC SCIENCES AND HUMANITIES

Math. 107/ Bio. 101	Fundamental Mathematics/ Introduction to Biology	2+1/3+0
Zoo. 201	Introduction to Animal Biodiversity	3+0
Bot. 202	Plant Morphology	3+0
Econ. 203	Introduction to Economics and Project Evaluation	2+0
Chem. 203	Physical and Inorganic Chemistry	2+1
Eng. 301	Communication Skills and Technical Writing	1+2
Pbi. 101	Basic Punjabi	0+2 (NC)
Stat. 201	Elementary Statistics	2+0
Micro. 202	Introduction to Microbiology	3+0
Phys. 202	Fundamentals of Biophysics	2+1
Biochem. 203	Structure and Function of Biomolecules	3+0
Bot. 203	Systematic Botany	3+0
Zoo. 203	Introduction to Cell Biology and Immunology	3+0
Chem. 204	Mechanism of organic reactions	2+1
Micro. 203	Basic Bacteriology	2+0
Biochem. 204	Metabolism-I	2+0
Bot. 204	Plant Histology	2+0
Micro. 204	Basic Mycology and Phycology	3+0
Zoo. 204	Introduction to Developmental Biology	2+0
Biochem. 205	Metabolism-II	3+0
Bot. 205	Botany of Economic Plants	2+0
Zoo. 304	Fundamentals of Animal Physiology	3+0
Chem. 301/	Fundamental Organic Chemistry/	3+0
Biochem. 303/	Introduction to Membrane Biochemistry	3+0
Bot. 307/	Plant Biodiversity and Environment/	2+1
Micro. 307/	BacterialGenetics	3+0
Zoo. 310/	Fundamentals of Animal Behaviour	2+1
Zoo. 405/	Introduction to Fish and Fisheries	2+1
Agron. 101/	Elements of Agronomy	2+1
PBG 102/	Introductory Genetics	2+0
Ent. 201/	Introductory Entomology	2+1
Pl. Path. 201	Diseases of Field Crops and their Management	2+1

(Optional)

Micro. 205	Basic Virology	2+0
Biochem. 206	General Enzymology	2+0
Bot. 301	Fundamentals of Plant Physiology	3+0
Biochem. 302	Basic Experiments in Biochemistry	0+3
Micro. 305	Basic Experiments in Microbiology	0+3
Zoo. 305	Fundamentals of Animal Ecology	2+0
Mgt. 421	Introduction to Management and Marketing	2+0
Eng. 201	Interactive Languages Proficiency	0+1
Env. 101	Environmental Studies and Disaster Management	2+0
Biochem. 301	Introduction to Molecular Biochemistry	3+0
Bot. 302	Basic Experiments in Botany	0+3
Micro. 304	Introduction to Applied Microbiology	3+0
Zoo. 306	Basic Experiments in Zoology	0+3
Edu. Tour	Educational Tour	0+2 (NC)
Bot. 303	Algae, Fungi and Lichens	2+1
Bot. 304	Bryophyta	2+1
Bot. 305	Pteridophyta	2+1
Bot. 306	Gymnosperms	2+1
Bot. 401	Plant Physiology-I (Plant Water Relations and Mineral Nutrition)	2+1
Bot. 402	Plant Physiology-II (Plant Metabolism)	2+1
Bot. 403	Plant Physiology-III (Growth, Differentiation and Morphogenesis)	2+1
		109+3/2 (optional)+ 4(NC) = 116/115

AGRICULTURE

1	Agron. 101/	Elements of Agronomy/	2+1*
	Ent. 201	Introductory Entomology	2+1*
	PBG 102	Introductory Genetics	2+0*
	Pl. Path. 201	Diseases of Field Crops and their Management	2+1*
2	Biotech. 303	Introduction to Nanobiotechnology	2+0
3	Biotech. 307	Introduction to Bioinformatics	2+1
4	Biotech. 401	Introduction to Genomics and Proteomics	3+0
			8

(*Credit hours already counted)

AGRICULTURE ENGINEERING AND TECHNOLOGY

1	CSE 101	Information and Communication Technology in Agriculture	1+2

HOME SCIENCE

1	HD 106	Human Values in Education	1+1

NSS/NSO/NCC

1	NSS/NSO/NCC	(SEM-I)	0+1 (NC)
2	NSS/NSO/NCC	(SEM-II)	0+1 (NC)
3	NSS/NSO/NCC	(SEM-III)	0+1 (NC)
4	NSS/NSO/NCC	(SEM-IV)	0+1 (NC)
			4 (NC)
		Total	129/128+4

(NC) =133/132

SEMESTER-WISE PROGRAMME FOR
5-YEAR INTEGRATED M.Sc. (Hons) IN BOTANY

FIRST YEAR			
SEM I		**SEM II**	
Math. 107/Bio. 101	2+1/3+0	CSE 101	1+2
Zoo. 201	3+0	Stat. 201	2+0
Bot. 202	3+0	Micro. 202	3+0
Econ. 203	2+0	Phys. 202	2+1
Chem. 203	2+1	Biochem. 203	3+0
Eng. 301	1+2	Bot. 203	3+0
Pbi. 101	0+2 (NC)	Zoo. 203	3+0
HD 106	1+1	Chem. 204	2+1
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3 (NC)=22	Total	23+1 (NC) = 24
SECOND YEAR			
SEM III		**SEM IV**	
Micro. 203	2+0	Micro. 205	2+0
Biochem. 204	2+0	Biochem. 206	2+0
Bot. 204	2+0	Bot. 301	3+0
Micro. 204	3+0	Biochem. 302	0+3
Zoo. 204	2+0	Micro. 305	0+3
Biochem. 205	3+0	Zoo. 305	2+0
Bot. 205	2+0	Biotech. 307	2+1
Zoo. 304	3+0	Mgt. 421	2+0
Chem. 301/Biochem. 303/	3+0/3+0/	Eng. 201	0+1
Bot. 307/Micro. 307/Zoo. 310/	2+1/3+0/2+1/	Env. 101	2+0
Zoo. 405/Agron. 101/PBG 102/	2+1/2+1/2+0/		
Ent. 201/Pl. Path. 201 (Optional)	2+1/2+1		
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3/2(optional) + 1(NC) = 23/22	Total	23+1 (NC) = 24
THIRD YEAR			
SEM V		**SEM VI**	
Biochem. 301	3+0	Bot. 304	2+1
Bot. 302	0+3	Bot. 305	2+1
Biotech. 303	2+0	Bot. 306	2+1
Micro. 304	3+0	Bot. 401	2+1
Zoo. 306	0+3	Bot. 402	2+1
Biotech. 401	3+0	Bot. 403	2+1
Bot. 303	2+1		
Edu. Tour	0+2 (NC)		
Total	20 + 2 (NC) = 22	Total	18

COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUTOF 5-YEAR INTEGRATED M.Sc. (Hons) PROGRAMME IN CHEMISTRY (CORE COURSES)

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES		**Cr. Hrs.** Th+Pr
For PCM base:		
Bio. 101	Introduction to Biology	3+0
For PCB base:		
Math. 107	Fundamental Mathematics	2+1

Regional Language

For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level

Pbi. 101	Basic Punjabi	0+2 (NC)

REQUIRED COURSES
BASIC SCIENCES AND HUMANITIES

Math. 107/Bio. 101	Fundamental Mathematics/Introduction to Biology	2+1/3+0
Zoo. 201	Introduction to Animal Biodiversity	3+0
Bot. 202	Plant Morphology	3+0
Econ. 203	Introduction to Economics and Project Evaluation	2+0
Chem. 201	Organic Chemistry	3+0
Eng. 301	Communication Skills and Technical Writing	1+2
Pbi. 101	Basic Punjabi	0+2 (NC)
Stat. 201	Elementary Statistics	2+0
Micro. 202	Introduction to Microbiology	3+0
Phys. 202	Fundamentals of Biophysics	2+1
Biochem. 203	Structure and Function of Biomolecules	3+0
Bot. 203	Systematic Botany	3+0
Zoo. 203	Introduction to Cell Biology and Immunology	3+0
Chem. 203	Physical and Inorganic Chemistry	2+1
Micro. 203	Basic Bacteriology	2+0
Biochem. 204	Metabolism-I	2+0
Chem. 302	Chemistry of Agrochemicals, Plant Products and Growth Regulators	1+1
Micro. 204	Basic Mycology and Phycology	3+0
Zoo. 204	Introduction to Developmental Biology	2+0
Biochem. 205	Metabolism-II	3+0
Bot. 205	Botany of Economic Plants	2+0
Stat. 202	Biostatistics	2+1
Chem. 301/	Fundamental Organic Chemistry/	3+0
Biochem. 303/	Introduction to Membrane Biochemistry	3+0
Bot. 307/	Plant Biodiversity and Environment/	2+1
Micro. 307/	BacterialGenetics	3+0
Zoo. 310/	Fundamentals of Animal Behaviour	2+1
Zoo. 405/	Introduction to Fish and Fisheries	2+1
Agron. 101/	Elements of Agronomy	2+1
PBG 102/	Introductory Genetics	2+0
Ent. 201/	Introductory Entomology	2+1
Pl. Path. 201 (Optional)	Diseases of Field Crops and their Management	2+1

Chem. 303	Thermodynamics and Chemical Kinetics	3+0
Biochem. 206	General Enzymology‘	2+0
Bot. 301	Fundamentals of Plant Physiology	3+0
Biochem. 302	Basic Experiments in Biochemistry	0+3
Chem. 304	Basic Analytical Chemistry	3+0
Chem. 305	Experiments in Inorganic Chemistry	0+2
Mgt. 421	Introduction to Management and Marketing	2+0
Env. 101	Environmental Studies and Disaster Management	2+0
Bot. 302	Basic Experiments in Botany	0+3
Math. 203	Biomathematics	2+1
Chem. 306	Fundamental Inorganic Chemistry	2+0
Chem. 423	General Organic Chemistry	2+0
Chem. 424	Radioactivity and Transition Elements	2+0
Edu. Tour	Educational Tour	0+2 (NC)
Chem. 422	Electrochemistry and Surface Chemistry	3+0
Chem. 425	Introduction to Metal Complexes and Chelates	2+1
Chem. 427	Spectroscopy and Structure Elucidation	2+0
Chem. 428	Experiments in Chemistry	0+3
Chem. 429	Drugs, Biomolecules and Polymers	3+0
Chem. 430	Fundamental Quantum and Solution Chemistry	3+0
Eng. 201	Interactive Languages Proficiency	0+1
		109+3/2 (optional) + 4(NC) =116/115

AGRICULTURE

1	Agron. 101/	Elements of Agronomy/	2+1*
	Ent. 201	Introductory Entomology	2+1*
	PBG 102	Introductory Genetics	2+0*
	Pl. Path. 201	Diseases of Field Crops and their Management	2+1*
2	Biotech. 303	Introduction to Nanobiotechnology	2+0
3	Biotech. 307	Introduction to Bioinformatics	2+1
4	Biotech. 401	Introduction to Genomics and Proteomics	3+0
			8

(*Credit hours already counted)

AGRICULTURE ENGINEERING AND TECHNOLOGY

1	CSE 101	Information and Communication Technology in Agriculture	1+2

HOME SCIENCE

1	HD 106	Human Values in Education	1+1

NSS/NSO/NCC

1	NSS/NSO/NCC	(SEM-I)	0+1 (NC)
2	NSS/NSO/NCC	(SEM-II)	0+1 (NC)
3	NSS/NSO/NCC	(SEM-III)	0+1 (NC)
4	NSS/NSO/NCC	(SEM-IV)	0+1 (NC)
			4 (NC)
		Total	129/128+4 (NC)=133/132

SEMESTER-WISE PROGRAMME FOR
5-YEAR INTEGRATED M.Sc. (Hons) in CHEMISTRY

FIRST YEAR

SEM I		SEM II	
Math. 107/Bio. 101	2+1/3+0	CSE 101	1+2
Zoo. 201	3+0	Stat. 201	2+0
Bot. 202	3+0	Micro. 202	3+0
Econ. 203	2+0	Phys. 202	2+1
Chem. 201	3+0	Biochem. 203	3+0
Eng. 301	1+2	Bot. 203	3+0
Pbi. 101	0+2 (NC)	Zoo. 203	3+0
HD 106	1+1	Chem. 203	2+1
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3 (NC) = 22	Total	23+1 (NC) = 24

SECOND YEAR

SEM III		SEM IV	
Micro. 203	2+0	Chem. 303	3+0
Biochem. 204	2+0	Biochem. 206	2+0
Chem. 302	1+1	Bot. 301	3+0
Micro. 204	3+0	Biochem. 302	0+3
Zoo. 204	2+0	Chem. 304	3+0
Biochem. 205	3+0	Chem. 305	0+2
Bot. 205	2+0	Biotech. 307	2+1
Stat. 202	2+1	Mgt. 421	2+0
Chem. 301/Biochem. 303/ Bot. 307/Micro. 307/Zoo. 310/ Zoo. 405/ Agron. 101/PBG 102/ Ent. 201/Pl. Path. 201 (Optional)	3+0/3+0/ 2+1/3+0/2+1/ 2+1/2+1/2+0/ 2+1/2+1	Env. 101	2+0
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3/2(optional) +1(NC)= 23/22	Total	23+1 (NC) = 24

THIRD YEAR

SEM V		SEM VI	
Biochem. 301	3+0	Chem. 422	3+0
Bot. 302	0+3	Chem. 425	2+1
Biotech. 303	2+0	Chem. 427	2+0
Math. 203	2+1	Chem. 428	0+3
Chem. 306	2+0	Chem. 429	3+0
Biotech. 401	3+0	Chem. 430	3+0
Chem. 423	2+0	Eng. 201	0+1
Chem. 424	2+0		
Edu. Tour	0+2 (NC)		
Total	20+2 (NC) = 22	Total	18

COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUT OF 5-YEAR INTEGRATED M.Sc. (Hons) PROGRAMME IN MICROBIOLOGY (CORE COURSES)

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES		**Cr. Hrs.** Th+Pr
For PCM base:		
Bio. 101	Introduction to Biology	3+0
For PCB base:		
Math. 107	Fundamental Mathematics	2+1

Regional Language

For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level

Pbi. 101	Basic Punjabi	0+2 (NC)

REQUIRED COURSES

BASIC SCIENCES AND HUMANITIES

Math. 107/Bio. 101	Fundamental Mathematics/Introduction to Biology	2+1/3+0
Zoo. 201	Introduction to Animal Biodiversity	3+0
Bot. 202	Plant Morphology	3+0
Econ. 203	Introduction to Economics and Project Evaluation	2+0
Chem. 203	Physical and Inorganic Chemistry	2+1
Eng. 301	Communication Skills and Technical Writing	1+2
Pbi. 101	Basic Punjabi	0+2 (NC)
Stat. 201	Elementary Statistics	2+0
Micro. 202	Introduction to Microbiology	3+0
Phys. 202	Fundamentals of Biophysics	2+1
Biochem. 203	Structure and Function of Biomolecules	3+0
Bot. 203	Systematic Botany	3+0
Zoo. 203	Introduction to Cell Biology and Immunology	3+0
Chem. 204	Mechanism of organic reactions	2+1
Micro. 203	Basic Bacteriology	2+0
Biochem. 204	Metabolism-I	2+0
Bot. 204	Plant Histology	2+0
Micro. 204	Basic Mycology and Phycology	3+0
Zoo. 204	Introduction to Developmental Biology	2+0
Biochem. 205	Metabolism-II	3+0
Bot. 205	Botany of Economic Plants	2+0
Zoo. 304	Fundamentals of Animal Physiology	3+0
Chem. 301/	Fundamental Organic Chemistry/	3+0
Biochem. 303/	Introduction to Membrane Biochemistry	3+0
Bot. 307/	Plant Biodiversity and Environment/	2+1
Micro. 307/	BacterialGenetics	3+0
Zoo. 310/	Fundamentals of Animal Behaviour	2+1
Zoo. 405/	Introduction to Fish and Fisheries	2+1
Agron. 101/	Elements of Agronomy	2+1
PBG 102/	Introductory Genetics	2+0

Ent. 201/	Introductory Entomology	2+1
Pl. Path. 201 (Optional)	Diseases of Field Crops and their Management	2+1
Micro. 205	Basic Virology	2+0
Biochem. 206	General Enzymology	2+0
Bot. 301	Fundamentals of Plant Physiology	3+0
Biochem. 302	Basic Experiments in Biochemistry	0+3
Micro. 305	Basic Experiments in Microbiology	0+3
Zoo. 305	Fundamentals of Animal Ecology	2+0
Mgt. 421	Introduction to Management and Marketing	2+0
Eng. 201	Interactive Languages Proficiency	0+1
Env. 101	Environmental Studies and Disaster Management	2+0
Biochem. 301	Introduction to Molecular Biochemistry	3+0
Bot. 302	Basic Experiments in Botany	0+3
Micro. 304	Introduction to Applied Microbiology	3+0
Zoo. 306	Basic Experiments in Zoology	0+3
Micro. 306	Fundamentals of Food and Dairy Microbiology	3+1
Micro. 303/ Biotech. 304	Introduction to Industrial Biotechnology	2+1
Edu Tour	Educational Tour	0+2 (NC)
Micro. 401	Practicals in Microbiology	0+2
Micro. 421	Fundamentals of Microbiology	2+1
Micro. 426	Fundamentals of Soil Microbiology	2+1
Micro. 427	Fundamentals of Environmental Microbiology	2+1
Micro. 428	Fundamentals of Clinical Microbiology	2+1
		109+3/2 (optional)+ 4(NC)=116/115

AGRICULTURE

1	Agron. 101/	Elements of Agronomy/	2+1*
	Ent. 201	Introductory Entomology	2+1*
	PBG 102	Introductory Genetics	2+0*
	Pl. Path. 201	Diseases of Field Crops and their Management	2+1*
2	Biotech. 303	Introduction to Nanobiotechnology	2+0
3	Biotech. 307	Introduction to Bioinformatics	2+1
4	Biotech. 401	Introduction to Genomics and Proteomics	3+0
			8

(*Credit hours already counted)

AGRICULTURE ENGINEERING AND TECHNOLOGY

1	CSE 101	Information and Communication Technology in Agriculture	1+2

HOME SCIENCE

1	HD 106	Human Values in Education	1+1

NSS/NSO/NCC

1	NSS/NSO/NCC	(SEM-I)	0+1 (NC)
2	NSS/NSO/NCC	(SEM-II)	0+1 (NC)
3	NSS/NSO/NCC	(SEM-III)	0+1 (NC)
4	NSS/NSO/NCC	(SEM-IV)	0+1 (NC)
			4 (NC)

Total	129/128+4 (NC)=133/132

SEMESTER-WISE PROGRAMME FOR
5-YEAR INTEGRATED M.Sc. (Hons) in MICROBIOLOGY

FIRST YEAR

SEM I		SEM II	
Math. 107/Bio. 101	2+1/3+0	CSE 101	1+2
Zoo. 201	3+0	Stat. 201	2+0
Bot. 202	3+0	Micro.202	3+0
Econ. 203	2+0	Phys. 202	2+1
Chem. 203	2+1	Biochem. 203	3+0
Eng. 301	1+2	Bot. 203	3+0
Pbi. 101	0+2 (NC)	Zoo. 203	3+0
HD 106	1+1	Chem. 204	2+1
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3 (NC)=22	Total	23+1 (NC) = 24

SECOND YEAR

SEM III			SEM IV	
Micro. 203	2+0		Micro. 205	2+0
Biochem. 204	2+0		Biochem. 206	2+0
Bot. 204	2+0		Bot. 301	3+0
Micro. 204	3+0		Biochem. 302	0+3
Zoo. 204	2+0		Micro. 305	0+3
Biochem. 205	3+0		Zoo. 305	2+0
Bot. 205	2+0		Biotech. 307	2+1
Zoo. 304	3+0		Mgt. 421	2+0
Chem. 301/Biochem. 303/	3+0/3+0/		Eng. 201	0+1
Bot. 307/Micro. 307/Zoo. 310/	2+1/3+0/2+1/		Env. 101	2+0
Zoo. 405/ Agron. 101/PBG 102/	2+1/2+1/2+0/			
Ent. 201/Pl. Path. 201 (Optional)	2+1/2+1			
NSS/NSO/NCC	0+1 (NC)		NSS/NSO/NCC	0+1 (NC)
Total	19+3/2(optional) +1(NC)= 23/22		Total	23+1 (NC) = 24

THIRD YEAR

SEM V		SEM VI	
Biochem. 301	3+0	Micro. 303/Biotech. 304	2+1
Bot. 302	0+3	Micro. 401	0+2
Biotech. 303	2+0	Micro. 421	2+1
Micro. 304	3+0	Micro. 426	2+1
Zoo. 306	0+3	Micro. 427	2+1
Biotech. 401	3+0	Micro. 428	2+1
Micro. 306	3+1		
Edu. Tour	0+2 (NC)		
Total	21+2 (NC) = 23	Total	17

COURSE CURRICULUM FOR AWARD OF 3-YEAR B.Sc. DEGREE ON OPTING OUTOF 5-YEAR INTEGRATED M.Sc. (Hons) PROGRAMME IN ZOOLOGY (CORE COURSES)

DEFICIENCY COURSES

BASIC SCIENCES AND HUMANITIES		**Cr. Hrs.** Th+Pr
For PCM base:		
Bio. 101	Introduction to Biology	3+0
For PCB base:		
Math. 107	Fundamental Mathematics	2+1

Regional Language

For students with domicile of Punjab who have not taken Punjabi at Matric/10+2 level

Pbi. 101	Basic Punjabi	0+2 (NC)

REQUIRED COURSES

BASIC SCIENCES AND HUMANITIES

Math. 107/Bio. 101	Fundamental Mathematics/Introduction to Biology	2+1/3+0
Zoo. 201	Introduction to Animal Biodiversity	3+0
Bot. 202	Plant Morphology	3+0
Econ. 203	Introduction to Economics and Project Evaluation	2+0
Chem. 203	Physical and Inorganic Chemistry	2+1
Eng. 301	Communication Skills and Technical Writing	1+2
Pbi. 101	Basic Punjabi	0+2 (NC)
Stat. 201	Elementary Statistics	2+0
Micro. 202	Introduction to Microbiology	3+0
Phys. 202	Fundamentals of Biophysics	2+1
Biochem. 203	Structure and Function of Biomolecules	3+0
Bot. 203	Systematic Botany	3+0
Zoo. 203	Introduction to Cell Biology and Immunology	3+0
Chem. 204	Mechanism of organic reactions	2+1
Micro. 203	Basic Bacteriology	2+0
Biochem. 204	Metabolism-I	2+0
Bot. 204	Plant Histology	2+0
Micro. 204	Basic Mycology and Phycology	3+0
Zoo. 204	Introduction to Developmental Biology	2+0
Biochem. 205	Metabolism-II	3+0
Bot. 205	Botany of Economic Plants	2+0
Zoo. 304	Fundamentals of Animal Physiology	3+0
Chem. 301/	Fundamental Organic Chemistry/	3+0
Biochem. 303/	Introduction to Membrane Biochemistry	3+0
Bot. 307/	Plant Biodiversity and Environment/	2+1
Micro. 307/	Bacterial Genetics	3+0
Zoo. 310/	Fundamentals of Animal Behaviour	2+1
Zoo. 405/	Introduction to Fish and Fisheries	2+1
Agron. 101/	Elements of Agronomy	2+1
PBG 102/	Introductory Genetics	2+0
Ent. 201/	Introductory Entomology	2+1
Pl. Path. 201 (Optional)	Diseases of Field Crops and their Management	2+1

Micro. 205	Basic Virology	2+0
Biochem. 206	General Enzymology	2+0
Bot. 301	Fundamentals of Plant Physiology	3+0
Biochem. 302	Basic Experiments in Biochemistry	0+3
Micro. 305	Basic Experiments in Microbiology	0+3
Zoo. 305	Fundamentals of Animal Ecology	2+0
Mgt. 421	Introduction to Management and Marketing	2+0
Eng. 201	Interactive Languages Proficiency	0+1
Env. 101	Environmental Studies and Disaster Management	2+0
Biochem. 301	Introduction to Molecular Biochemistry	3+0
Bot. 302	Basic Experiments in Botany	0+3
Micro. 304	Introduction to Applied Microbiology	3+0
Zoo. 306	Basic Experiments in Zoology	0+3
Zoo. 307	Systematics and Evolution of Animals	2+1
Edu. Tour	Educational Tour	0+2 (NC)
Zoo. 308	Applied Zoology	3+1
Zoo. 309	Zootechniques	1+1
Zoo. 401	Form, Structure and Function of Invertebrates	3+1
Zoo. 402	Form, Structure and Function of Vertebrates	2+1
Zoo. 403	Cell Biology and Development in Animals	2+1
Zoo. 404	Environmental Biology and Management	2+1
		110+3/2 (optional)+ 4(NC)=117/116

AGRICULTURE

1	Agron. 101/	Elements of Agronomy/	2+1*
	Ent. 201	Introductory Entomology	2+1*
	PBG 102	Introductory Genetics	2+0*
2	Biotech. 303	Introduction to Nanobiotechnology	2+0
3	Biotech. 307	Introduction to Bioinformatics	2+1
4	Biotech. 401	Introduction to Genomics and Proteomics	3+0
	(*Credit hours already counted)		8

AGRICULTURE ENGINEERING AND TECHNOLOGY

1	CSE 101	Information and Communication Technology in Agriculture	1+2

HOME SCIENCE

1	HD 106	Human Values in Education	1+1

NSS/NSO/NCC

1	NSS/NSO/NCC	(SEM-I)	0+1 (NC)
2	NSS/NSO/NCC	(SEM-II)	0+1 (NC)
3	NSS/NSO/NCC	(SEM-III)	0+1 (NC)
4	NSS/NSO/NCC	(SEM-IV)	0+1 (NC)
			4 (NC)
		Total	130/129+4

(NC) =134/133

SEMESTER-WISE PROGRAMME FOR
5-YEAR INTEGRATED M.Sc. (Hons) in ZOOLOGY

FIRST YEAR

SEM I		SEM II	
Math. 107/Bio. 101	2+1/3+0	CSE 101	1+2
Zoo. 201	3+0	Stat. 201	2+0
Bot. 202	3+0	Micro. 202	3+0
Econ. 203	2+0	Phys. 202	2+1
Chem. 203	2+1	Biochem. 203	3+0
Eng. 301	1+2	Bot. 203	3+0
Pbi. 101	0+2 (NC)	Zoo. 203	3+0
HD 106	1+1	Chem. 204	2+1
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3 (NC)=22	Total	23+1 (NC) = 24

SECOND YEAR

SEM III			SEM IV
Micro. 203	2+0	Micro. 205	2+0
Biochem. 204	2+0	Biochem. 206	2+0
Bot. 204	2+0	Bot. 301	3+0
Micro. 204	3+0	Biochem. 302	0+3
Zoo. 204	2+0	Micro. 305	0+3
Biochem. 205	3+0	Zoo. 305	2+0
Bot. 205	2+0	Biotech. 307	2+1
Zoo. 304	3+0	Mgt. 421	2+0
Chem. 301/Biochem. 303/	3+0/3+0/	Eng. 201	0+1
Bot. 307/Micro. 307/Zoo. 310/	2+1/3+0/2+1/	Env. 101	2+0
Zoo. 405/ Agron. 101/PBG 102/	2+1/2+1/2+0/		
Ent. 201/Pl. Path. 201 (Optional)	2+1/2+1		
NSS/NSO/NCC	0+1 (NC)	NSS/NSO/NCC	0+1 (NC)
Total	19+3/2(optional) + 1(NC)= 23/22	Total	23+1 (NC) = 24

THIRD YEAR

SEM V		SEM VI	
Biochem. 301	3+0	Zoo. 308	3+1
Bot. 302	0+3	Zoo. 309	1+1
Biotech. 303	2+0	Zoo. 401	3+1
Micro. 304	3+0	Zoo. 402	2+1
Zoo. 306	0+3	Zoo. 403	2+1
Biotech. 401	3+0	Zoo. 404	2+1
Zoo. 307	2+1		
Edu. Tour	0+2 (NC)		
Total	20 + 2 (NC) = 22	Total	19